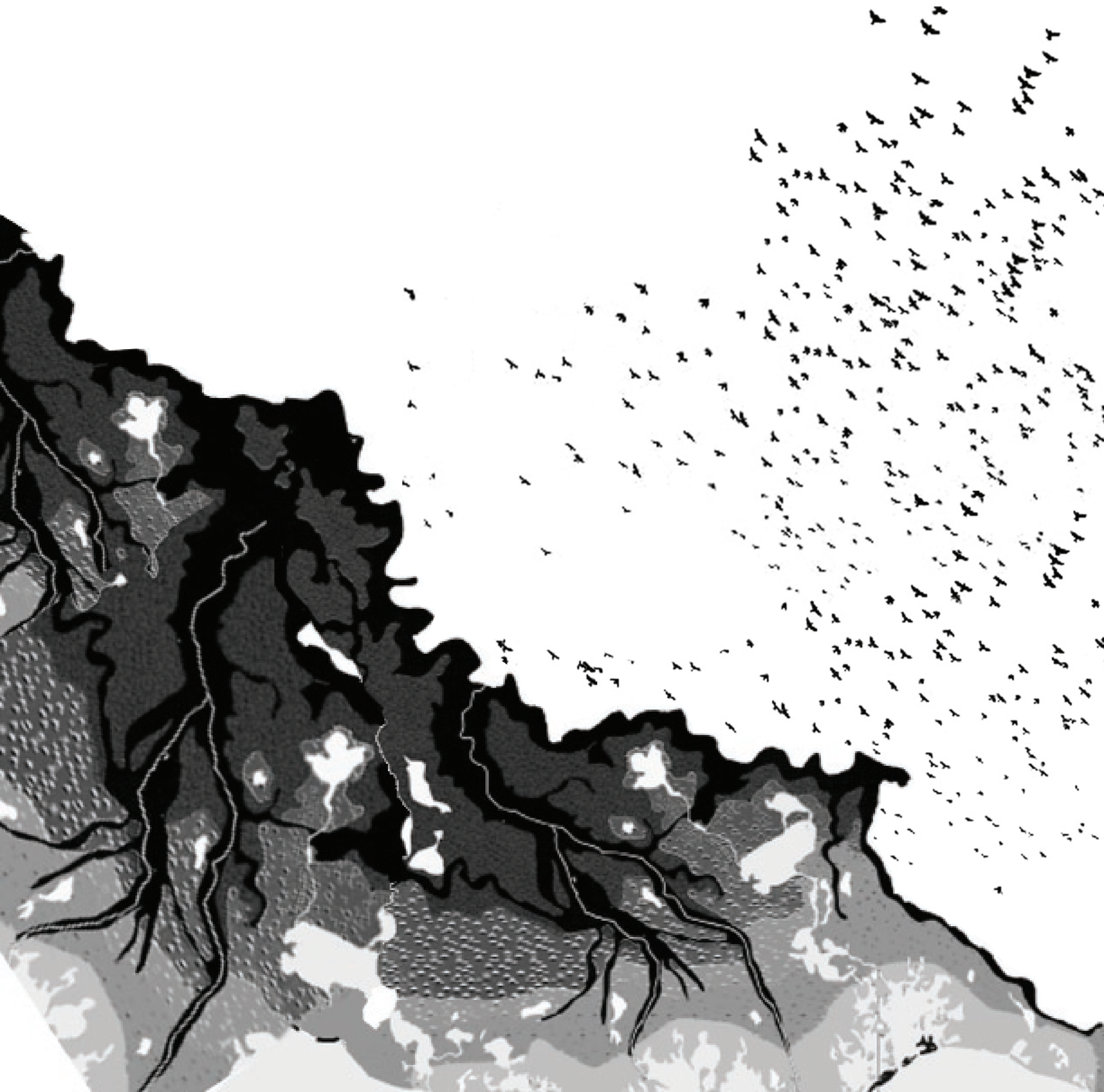
Resilience: cooperation of Social and Ecological systems

DESIGN THESIS

PATRICK CORRIGAN

May 11 , 2011



We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.

~Aldo Leopold, A Sand County Almanac

Resilience: cooperation of Social and Ecological systems

A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
of North Dakota State University

By

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In Partial Fulfillment of the Requirements
for the Degree of
Bachlors of Landscape Architecture

Primary Thesis Advisor

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May 11, 2011
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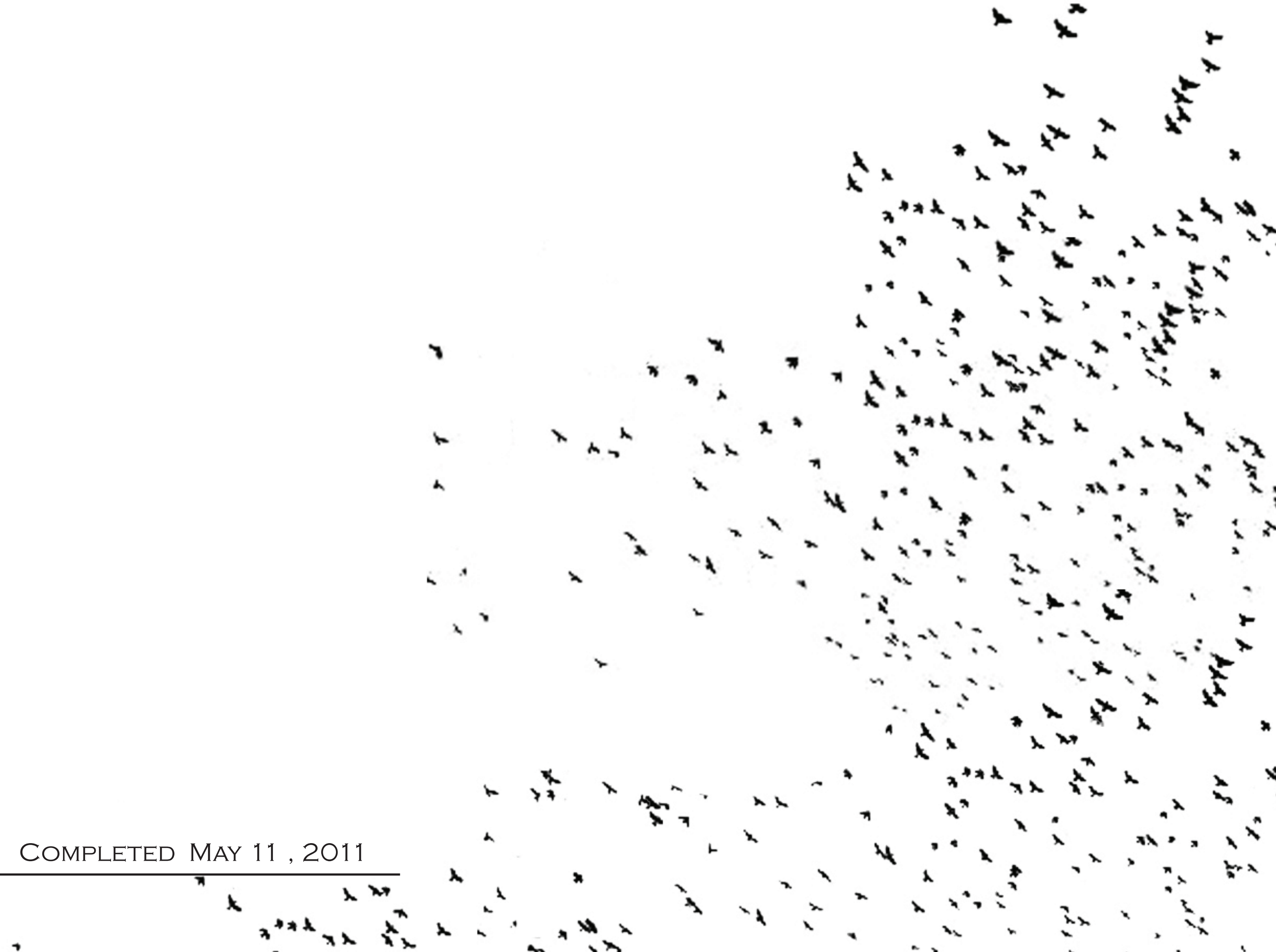


Completed May 11 , 2011

Abstract

Within recent years there has been a monumental awareness put towards environmental sustainability and resilience in response to the effects of humankind's continued imposition on existant ecological processes. Whether they be industrial developments or more specifically agricultural practices, continued fragmentation of complex adaptive systems creates radical changes in ecological systems that extend far beyond a given developmental footprint. If adequate balances can be reached between agriculture and natural processes more aspects of landscape resilience can successfully adapt to the inevitable changes in the worlds ecology. Allowing ecological systems to continue is crucial to the preservation of all life and progression planet wide.

An assessment and synthesis of complex adaptive systems across the Western Rice Creek watershed, an approximate 800,000 acres, will be condensed and explained in the following texts, to illustrate the interactions among social-ecological components in a given landscape. A compiled developmental plan for the county will illustrate the most efficient use of lands to support ecological resilience. And more directly detail the disturbance regimes from massive hydrological flooding that is currently common throughout the area. The main issues being storm water retention, hydrological filtration, critical slow variables, disturbance regimes, alternative stable states, and cross-scale linkages among adaptive cycles all of witch relate to both ecological systems that interconnect with existing or growing social systems.

By creating an adaptive management plan for sustainable agriculture and watershed restoration, we can maximize the greatest benefits that arise from maintaining as many site specific variables and interactions as possible. If we can reach a balance that is mutually beneficial to human ways of life while still fostering ecological awareness towards sustaining resilience we can make sure our natural systems can still be used and enjoyed for future generations.

Keywords:

Storm water management, hydrological filtration, adaptive management, ecological resilience, disturbance regimes, alternative stable states, complex adaptive systems, social-ecological resilience

Problem Statement

How can cooperative land management repair ecological fragmentation caused by modern agricultural practices.

Statement of Intent

Typology:

Approximate 1,490,000 acre passive and adaptive social-ecological management plan to reduce seasonal flooding and connect fragmented ecological systems within the Western Rice Creek watershed in south eastern North Dakota.

Claim:

Agricultural processes are not necessarily negative but their existence can radically change ecological processes that extend well beyond a developmental footprint. Currently the interruption of nutrient cycles and trophic functions in ecosystems has lead to a degradation of natural resilience and consequent ecological regime shift of regional landscapes.

Premises:

-Since it's original development, agriculture has inherently conflicted with natural progression, succession, and continued sustainability.

-The modifying of once ecologically sustainable landscapes radiates immensely by drastically changing what lies within a developmental footprint, but more importantly it's interruption of large and complex biological systems that extend across entire landscapes.

-If certain ecological processes become too fragmented or pushed to far they can break down completely, exponentially magnifying ecological changes and damages already being done.

-Because life and bio-systems on this earth are the product of millions of years of slow evolutionary refinement, the smallest changes to biological structures can drastically effect all manner of life and function on countless scales within trophic hierarchies.

Theoretical Premise/Unifying Idea:

To ensure future ecological resilience societies must mutually create a cooperation of land development and agricultural practices to minimize their environmental fragmentation and maximize their control of now modified water systems.

Project Justification:

Allowing ecological systems to continue is crucial to the preservation of life, social functions, and resilience not only in the Red River Valley and the prairie pothole region but nationally, and planet wide. If adequate balances can be reached between agriculture and natural processes, other aspects of environmental functionality can successfully adapt to the inevitable changes in the worlds ecology.

Narrative

In the Neolithic Revolution humankind transitioned from hunting and gathering to agriculture and settlement, developing into a more agrarian society. During the next millennium the small and mobile groups of hunter-gatherers that had dominated human history shifted into sedentary societies which through time radically modified their natural environment by creating technologies and practices for specialized food-crop cultivation (e.g., irrigation, clear cutting, and food storage technologies).

In this country post Industrial Revolution farming took another leap in the increased mechanization of their necessary technologies. Exponentially our small interventions and developments begin is increase in size and frequency, meaning our once passive dependence has changed to a imperial domination of the world so that we may shape ecosystem services in to our vision and our short term needs. We see drainage of once important water ways and wetlands, modification of channelized water flows, increase nitrification from farmland runoff, increasing water use from crop irrigation, and the destruction of sustainable habitats that foster function of water resources. Ecologically we see a loss of biodiversity, species richness, and trophic hierarchies due to habitat loss and fragmentation.

Because life and bio-systems on this earth are the product of millions of years of slow evolutionary refinement, the simplest changes to biological structures can drastically effect all manner of life and function on countless scales within trophic hierarchies. (Site Ecology Book) Subsequently the new generations must inherit what we have created, eutrophication in our lakes and ponds, massive seasonal flooding, a contaminated water table and aquifer, broken down and fragmented ecological systems, scattering of endemic and local wildlife populations, as well as a lack of preserved natural space and an ecological biome with such an intense disturbance regime that little else but invasive species and mono cultures can survive. Even if a given system still provides its fundamental ecosystem services, its separation from other similar systems makes it less likely to incorporate other mutual process making the given space and land very non efficient in terms of utilization and overall functionality.

With the rise in environmentalism and the concepts of resource conservation and management, its evident agricultural practices have become more advanced and refined as we discover technologies and operations that are more efficient and sustainable. This thesis looks to create a paradigm shift in the way we look at agriculture and natural systems. It offers that a single developmental plan that encompasses as many variables as possible that can foster an efficient and mutually beneficial land utilization. By taking small yet cumulative measures within a specific landscape many now fragmented systems can be repaired or reconnected. The last remnants of open prairie land and undeveloped land located in south eastern North Dakota need to be collaborated for not only managing water availability and fluctuations but connecting massive ecological corridors that stretch across entire landscapes.

The development of land and the spread of our developmental societies is inevitable, our rapid and radical changes to natural succession and evolution have left scares upon the planet that will take thousands of years to be reversed. Certain planners and preservationists must accept this great shift in biological systems and help our dominant life sustaining systems adapt and gain resilience in these new and inevitable states of change.

User Client Description

Designed For:

This management plan would be compiled for the United States department of Agriculture (USDA), specifically the Natural Resource Conservation Service (NRCS). With respect to flora and fauna management in the watershed the US fish and Wildlife service will also be integral in planning and cooperating conservation. The plan will then be made publicly available on existing GIS servers for the designated counties in which the watershed resides.

Included in design:

Individuals affected by in the design can easily reach numbers in the thousands; encompassing any and all land owners that fall within the management footprint and designed green way, drainage systems, and upstream storage. These owners range from private to public land owners, existing nature reserve and park owners in both city and state offices, as well as fragmented or parceled land available for purchased by a governmental sector. Much proposed land is in existing swales and tributaries but much will be proposed over current farm land making rural farmers and ranchers the biggest constituent to be affected by but still inherently involved in this plan.

The largest asset and attractant for landowners to this proposal is the benefit of increased crop productivity, government subsidies and paybacks for management efforts, and more monetary value for their piece of land. These people are the ones most effected by the floods and hydrological disturbances, people who fight the rising waters year in and out, people who are no longer happy with losing money, land, and piece of mind to flooding on a yearly basis.

All of these new interventions and changes to a private land must not come at an inconvenience to landowners or come off as a detriment to the his/her job or way of life. In order to have success where others have failed these implementations must be mutually beneficial for everyone involved economically, environmentally, and culturally. Participants must also be willing to allow a few introductory studies and check ups onto their modified lands, in addition to the actual construction of the area's proposed measures.

Major Elements

Hydrological assessment

To identify the greatest variables within the watershed's hydrological processes, the most essential data will include county wide hydrological assessment of peak water flows, retention ponds and depressions, main lotic tributaries and channels, water clarity analysis and contamination measurement with regard to particles in suspension. This gives important information on current levels of degradation, contamination or potential restoration, and efficient utilization of water resources over the entire county. Mitigation measures concerning nitrogen runoff from fields and/or manure pits, farm drainage, or large field dosing of chemicals, are all concerns that become a strong focus dictating where hydrological areas are and how they will function.

Ecological assessment

A comprehensive assessment utilizing USGS maps, soil survey inventory, existing plant and animal life/migration, and localized and documented ecological patterns for the county. This will give the plan a current and historical benchmark for managing species within the county and how to best adhere to the flora and fauna that are the focus of much of the habitat preservation. Endemic species along with migratory birds and insects all must benefit from land use modifications, not only the monetary value for who owns the land. Wildlife hunting and fishing are a very large part of North Dakota life, culture and economy. Bringing in tourist capital from neighboring states, especially Minnesota, can support many of the ecological modifications as long as they benefit or ensure the survival and abundance of their desired game.

Vegetative and Land Use Assessment

Mainly GIS and USDA Survey data will be used to determine surviveing native plant communities that exist or could exist in the study area. Understanding what vegetation and species density are present creates greater gradients of efficiency in the management plan. Land use analysis will show how land is currently being used and developed versus how it has progressed from the past and what changes are coming. Knowing land usages helps predict where main areas of ecological change are and how to study areas the will progress based on frequency of use, crops or cattle, and overall recreation in a given area.

Economic and Cultural Assessment

This facet will look into the specific culture and economy of the site and its contextual influences. Is the area economically strong enough to adopt a policy or are there any people who will support a plan such as this; is it being proposed with the lives of the affected people in mind? Cultural assessments will look at the county's specific heritage, traditions, and beliefs as apposed to other areas along the Red River.

Governmental Institutions

Here is where the management plan looks to encompass multiple groups, boards, and offices both governmental and civilian to take on the role of implementation and management of the ongoing management plan. The real strength of the design will hinge on the ease of cooperation and benefits received by the landowners giving up their land uses to better sustain the environment. Compiling as many programs and government subsidies will give this report feasibility and large scale acceptability. Programs like CRP land, US forestry land, shore land restoration incentives, wetland credits, and hydrological filtration and retention programs are all examples of successful programs currently in use across North Dakota.

Master Plan

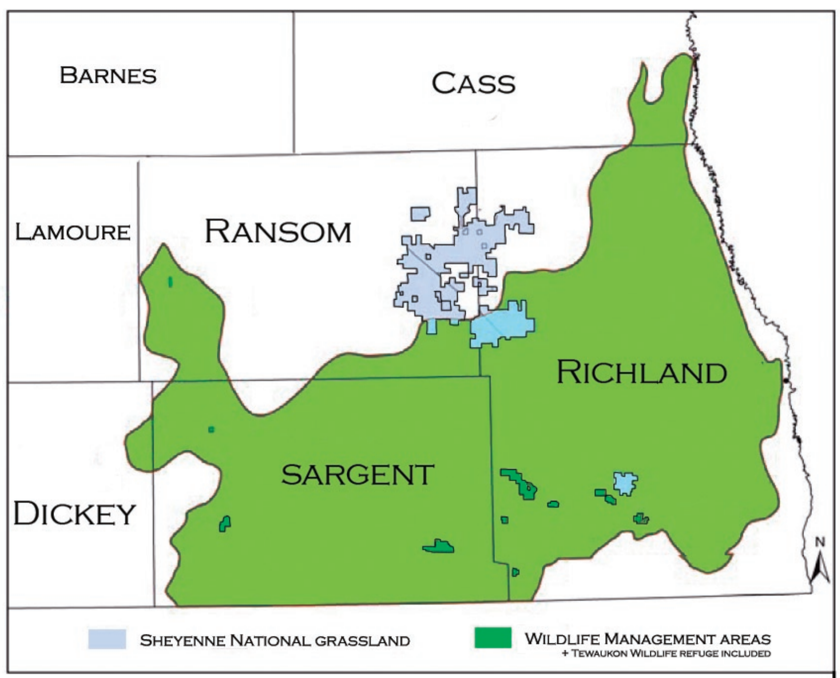
The final thesis will be a comprehensive and all encompassing plan that will incorporate as many facets of ecological resilience as possible to make applicable, manageable and efficient uses of land that is currently in a detrimental state. Ultimate result being a map spanning the watershed, highlighting areas that are most suitable for economical and environmental resource development based a number of relating variables. Further break down of largely complex townships, or more populated areas, will be done in detail for convenience and a more in depth explanation of dictating factors.

Site Information

Located in the Red River Valley the maganegemnt plan will take on the shape of a spicific watershed, in this case the Wester Wild rice watershed in North Dakota. It lies just north of the Midwest's continental divide sending most streams and rivers north. Its location is directly on the transition between eastern hardwood and tall grass prairie in the Dakotas. With the majority of the land put towards agriculture and cattle, much of the food production in the Midwest goes to feeding the rest of the country. Here hunting, fishing, and outdoor recreation is a large part of society. As such, programs like CRP and land shares work well. North Dakota is also one of the most economically stable states in the country with agriculture maintaining economic prominence as oil becomes bigger and bigger.

Site / county

In a northern progression up the Red River Valley Richland County contains the last bit of topography before the Sheyenne grasslands end the ecological transitions. The county is bordered on two very important and well known river ways in the Midwest, the Red river to the East and the Sheyenne River to the North, both are notorious for large seasonal flooding that had plagued the landowners of the region since its original settlement. The biodiversity in the area is quite large due to the topography, lakes, streams, and open space that allows for greater resilience and sustainability for habitat.



Wildlife Management Areas w/ National Grasslands
Western Wild Rice Watershed: HUC - 09020105

*** HUC: Hydrologic Unit Code for Wester Wild Rice Watershed*

Site Importance

This county serves as the perfect intermediary between the Red River Valley and the Sheyenne National Grasslands, both containing some of the last intact, functioning, dominant ecological zones in the great plains. By connecting these two adjacent assets there are countless environmental cycles and process that can benefit by de-fragmenting the natural areas is this county. It also contains a few other paralleling waterways making inter-connectivity even easier but also allowing design space for water retention. Because this area is so important to downstream flooding due to its potential for up stream retention. Preserving storage and recharge areas for peak water seasons is crucial to the success of any management plan this county.

The area is also great for encouraging outdoor recreating and cooperative land management practices. Example; Sheyenne Grasslands grazing rights co-op to the west. The well known scenic potential and waterfowl hunting make resource management an issue that is not to far from the minds of the general populace in this corner of North Dakota.

Project Emphasis

Restoring dominant waterways to create holistic ecological landscapes that benefit natural life and processes along with human growth and development. By restoring the waterways and green ways of our rivers we improve the regions resilience to environmental change. These rivers are the veins that ensure a greater ecological service through their connectivity.

The Thesis hinges on three main concepts in three main forms. Mass data assessment, synthesis and application into three interconnected mediums being environmental, social, and economical. The one overlying idea is the use of all this gathered data to create the most efficient land use possible in terms of ecological restoration and resilience, all through restoring crucial water availability and understanding the major effects we can have on intricate systems within our cultural environment.

Research

To ensure efficiency in the creation of this proposal all research shall remain relevant and useful in accordance with the research strategy stated below.

Methodologies

This will be a mixed method Quantitative/ Qualitative approach to balance the mass amounts of data and visual information that will be gathered in research. Qualitative understanding will ensure I know which area require more detail and which require less; always with a cumulative reference to the master plan. The beginning phases will primarily be of quantitative research due to the nature of large scale mapping and ecological overlays on a county scale.

Direction

Main sources for information will be existing NRCS maps, soil surveys, Rangeland management maps, and GIS. Using computed technologies will help synthesize lots of data into a medium understandable by academic readers as well as landowners to whom this thesis might pertain. A number of single person interviews may need to be conducted to ensure an up-to-date survey within the county to be recorded, because these are the people who will be sacrificing land. Also, because recent flooding issues become a large problem for residence lots of hydrological data will be easily accessible for water flows, watersheds, management incentives, etc. Horticultural and plant species must be refined to find the most successful or native options for a given area, examples like weather its oak savanna or cattail wetland, in order to control the spread of invasive species.

Documenting the Process

The research will be done in multiple phases for each according emphasis and important element:

-Hydrology,
-Ecology,
-Land use,
-Economics
-Owner incentives

All maps should relate on scale and form all based on a county wide scale. All documents and maps will be categorized by its given elements both electronically and as personal hard copies. Digital copies are available upon request.

Mass data is at the core of this thesis work and as such there must be organization and sufficient categorization of information gathered and work done thought the process. All research will be logged and documented accurately to ensure all things are relating sufficiently. Digital maps will be supplemented with hand renderings of area of more detail.

Research proposal

Literary analysis

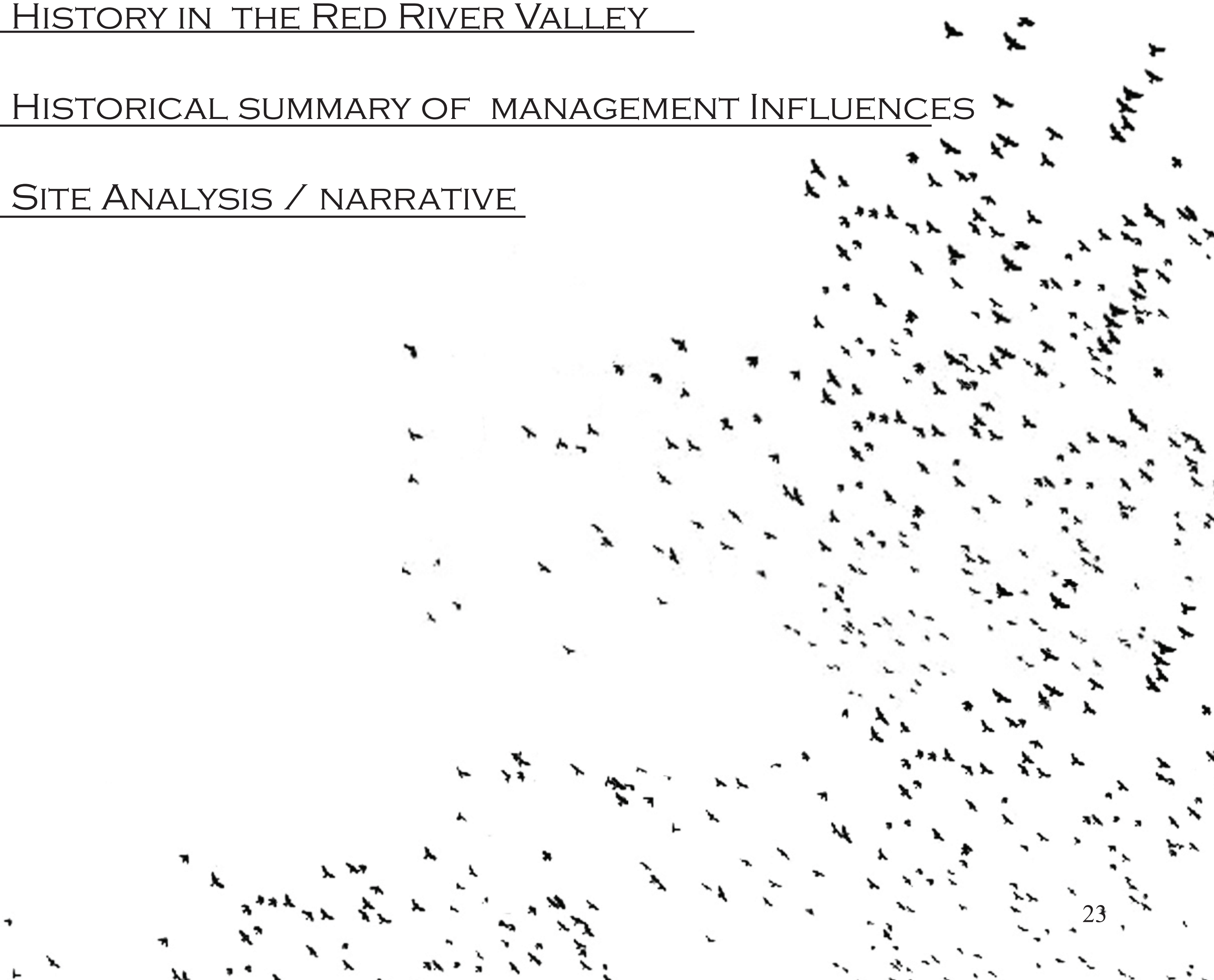
Theoretical Premise/Unifying Idea Research

Typological Research

History in the Red River Valley

Historical summary of management Influences

Site Analysis / narrative



As a theoretical and literary approach to this project I looked to important writings that helped create the environmental awareness and conservation system we have today. These three texts range from poetic historical literature to modern ecological management system; all of which helped to understand the real fundamental need for such and exhaustive effort to conserve the resources that could be put to so many other uses. One is an American classic by Henry David Thoreau called Walden; or, Life in the Woods, this being most the poetic and philosophical of my readings, at the other end of the gambit there is the Principles of Ecosystem Stewardship; Resilience-Based Natural Resource Management in a Changing World, which is an educational text on modern management systems that mutually benefit ecological systems and developmental economies. The final book is a personal favorite and like many others has pushed me pursue a career in resource management; and that is Aldo Leopold's, A Sand County Almanac.

I was raised on a small farm in central Minnesota, I grew up on some 120 acres of hardwood forest with a few ponds and a stream running along the edge. With few horses to keep us busy with a father as a natural resources manager for Minnesota and avid hunter in any sense of the word I had all I wanted of the natural world and its wonders. All of this resonate in me today as the driving force in my want to keep that sliver of sublime still alive for future generations. And yet as beautiful as that may sound not everyone sees the world through the same eyes. What is it then that so universally resonates within us all as humans. How did these writers speak in a language that they themselves created yet it is still able to stir strong enough feelings and emotions across an entire spectrum? How can you convince the average American farmer to dedicate land to nature rather than their own crop production?

In culmination and overall insight these three readings really show the spectrum of change that can all occur within the same movement of environmental preservation. We have the historical mentalities and insights of the poetic environmental writers on one side, and the calculated, scientific, and analytical approach to multi-systems management on the other. One can't help but draw parallels from the transcendental paradigm shift to the past and present environmental movements. The older writings exemplify what truly draws us all to nature and why it is so important to preserve nature's uniqueness and foster its progression for all life on the planet. As creatures of this earth we must always return to it in some shape or form weather ultimately or subconsciously. These writings speak to the destruction of not only multi-dimensional life systems that span entire landscapes but ". . . all things mysterious and unexplored. That land and sea be infinitely wild unsurveyed and unfathomed." (Leopold). When it comes down to justification for the fragmentation or destruction of these systems they are all eventually destroyed by means of our monetary and economic reduction of these once limitless entities.

To solve this we need not revert to solitude or some primal existence as exemplified in Thoreau's, *Walden; or, Life In The Woods* (Thoreau, 1962), but we do see the beautiful culmination of the idea of perfect symbiosis and stewardship of the environment brought to bear in Aldo Leopold's, *A Sand County Almanac*. As a conservationist, forester, and professor, Leopold was able to understand the beauty and sublime nature that resonates in much of Thoreau's witting, and still apply it to the foundation of preserving and maintaining nature and the environment. His insights into both the want and need for natural preservation, as well as the political and economic issues that go along with environmental conservation. As a student of history, Leopold understood that ethics guide individual people to cooperate with one another for the good of their families and communities. As a life-long student of the land, Leopold saw that communities include not just people but all elements of the natural world, including soils, waters, plants, and animals, "or collectively: the land." Leopold lived and worked in a period of history when people were leaving farms, forests, and small rural towns and losing their direct connections to the land. He saw that treating the natural world with love and respect would be difficult unless people found ways to stay connected to the natural world. Just as each person is asked to do their part in creating a just society, in this essay Leopold asks readers to see that they must play a part in protecting and preserving a healthy, productive, and beautiful planet. He calls on the reader to help create an "ecological conscience", a common sense of what is right and wrong when it comes to how we relate to land.

The problem is the fact that all these men lived in different times both economically and culturally. Many of their underlying ideas are just that; ideas and philosophies meant to resonate with the general public and raise our love of the natural world. Rarely do they dive into the practical means of facilitating or achieving such a shift in culture and typology. To understand how this can be addressed in a present day utilization we can study a number of modern educational journals and texts to help us frame these ideas. The one in particular I chose is, Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World. Here is where one can understand the basic foundation for feasibility and programing that can be integrated into a final compilation of sound research. This framework is based on stewardship of ecosystems for human well-being in a world dominated by uncertainty and change.

The book links recent advances in the theory of nature's resilience, sustainability, and vulnerability in the face of anthropomorphic changes; with practical issues of natural resources management and governance. The texts coin the term "Social-Ecological Systems" meaning all systems in which people depend on resources and services provided by ecosystems, and ecosystem dynamics are influenced, to varying degrees, by human activities. With the addition of present day economic, cultural, and social systems into existing or fragmented environmental systems we can hopefully find a vehicle for our desired co-operative land management end game.

The values of specific wetlands, waterways and their associated ecosystem services has been estimated at US$14 trillion annually.(source valuing wetlands) Yet many of these services, such as the recharge of groundwater, water purification or aesthetic and cultural values are not immediately obvious when one looks at these entities. Planners and decision-makers at many levels are losing awareness of the connections between wetland condition and the provision of wetland services and the consequent benefits for people; benefits which often have substantial economic value. Some argue, ironically, that the cause for the greatest part of this disconnections is fragmentation in the political sector. This lack of understanding and recognition leads to ill-informed decisions on management and development, which contribute to the continued rapid loss, conversion and degradation of wetlands - despite the total economic value of unconverted wetlands often being greater than that of converted wetlands.

With the concepts, emotions, and philosophies from some of our nations greatest environmental writers augmented with a systematic structure for social and environmental systems, hopefully a truly mutually beneficial balance can be discovered to ensure the future success of not only our economy and society but our cherished environment as well.

The Red River Valley of North Dakota/Minnesota is the youngest major land surface in the contiguous United States, having been subaerially exposed upon the final regional drainage of the waters within Glacial Lake Agassiz about 9,200 years ago. (Schwert, D., 2010). Therefore, whereas most river systems in the United States date in ages in the millions or even tens of millions of years, the present course of the Red River of the North is only a few thousands of years old. Underlying the Red River Valley are soils that induce both great agricultural activity and challenging geo-technical conditions. Soils are developed on a wedge of clays and silty-clays derived of late-glacial erosion and dispersed as suspended sediments into Lake Agassiz. Being north of the continental divide that transacts the state of North Dakota, uniquely the Red River flows northward and as such you must remember at the same time, spring thaw progresses steadily northward along the valley and eventually into Canada. Thus, along the course of the Red River, runoff from the southern portion of the Red River Valley progressively can join with fresh, melt-off from more northerly localities. If this synchrony is perfect (as it was during the major floods of Spring, 1997, and 2003, and 2010), the consequences for the northern portions of the Valley can be particularly disastrous. (Strom 2004)

It is in this setting of inevitable, large-scale floods and of weak, plastic soils that the area is now renown for, that some of the largest cities of northwestern Minnesota and eastern North Dakota are located (USDA Data layer) . These cities developed as agricultural centers at points where the east-west railroad lines crossed the north-south river transportation route. It no surprise to find any great civilizations along major water ways, ironically when first explored this area was marked as "The Nile of the Western Hemisphere," on the legend on the first geologic map of North Dakota. (Courtesy of the Clay County Historical Society). But, in a geologic perspective, these cities (Wahpeton-Breckenridge, Fargo-Moorhead, and Grand Forks-East Grand Forks) are mistakes – cities that are misplaced on a geologic terrain friendly to agriculture but highly unfriendly to human settlement. (Schwert, D., 2010). Their original conception was sincere but early farmers and ranchers had no idea of the damages that their anthropomorphic effects would have on the resiliency of the already fluctuating river system.

The Red River Valley constitutes one of the largest regions in the world where mankind has severely altered the natural ecology and physiography. Along with the lack of natural biological systems comes the fact that many of the remaining pieces of functioning ecosystems occur in tiny remnants like in preserves parks and refuges, even natural waterways, near railroads, and in cemeteries. More than 28,000 miles of ditches now drain what had been seasonally wet prairies of the Red River Valley, especially east of the river (Bluemle, 1997). One of the greatest problems of the region relates to how large-scale drainage and agriculture influences runoff in the Red River Valley.

Every since our original steps on the great plains agriculture and urbanization has had a profound impact on existing natural and constructed drainage systems. Development usually results in increased amounts of impervious surfaces, such as roof, streets, parking lots, newly planted fields, tilled land, or sparsely vegetated areas. The consequences of these surface changes are numerous but are primarily rooted in the fact that developed sites loss much of their natural stormwater storage capacity. The loss of vegetation, organic littler, and changes in surface characteristics such as roughness and perviousness, result in the rapid conversion of rainfall to stormwater run off. Often the increased rate and volume of runoff become to great for existing drainage systems to handle. In order to accommodate the increases, drainage systems are structurally altered through the use of pipes, gutters, channels, and storm sewers to direct and convey runoff away from developed areas. (George 2009)

There are several environmental impacts that may result from changes in the storm drain pattern. These include flood potential due to increase in peak flow rates. Decreased groundwater supply caused by reduced infiltration means increased soil erosion and sedimentation brought about by greater runoff volumes and velocities. Other factors include increased petrochemical pollution from streets in urban areas and farm runoff and the contamination of seasonal runoff by salt, sand, and nitrogen. Addressing these and other issues in the design and implementation phases will result in a more environmentally responsive management system. Resulting surface connectivity has been reduced and floodplain habits have been fragmented. At present, lateral exchange processes of energy within ecosystems are restricted to short-term pulses, while most of the year backwater processes are decoupled from the river system.

The variety of changes in natural stream hydrology and ecological function as a result from development can now be actuality documented as seen in a study conducted in south central North Dakota by the National Park service (Ripple and Beschta, 2007). They concluded trophic cascade has actually resulted in a complete lack of specific tree succession though out the Dakota grasslands. In hydrological systems peak discharges, which can be as much as two to five times their original rate, generally increase the frequency and severity of flooding by nearly the same increments. Land and habitats that had once been considered above flood level may become subject to flood damage, along with increased rates of runoff also increases as a result from reduced infiltration and storm water storage capacity. Higher runoff velocities, which also reduces the time it takes the peak discharge from a given storm to reach a stream or drainage channel, result from smoother surfaces like pavements or clay like soils which create less friction to slow water flow. Increased velocities and/or shorter overland travel times also provide less opportunity for infiltration. Higher velocities coupled with increased imperviousness may also result in reduced stream flow during extended dry periods caused by reduced infiltration. Groundwater that would normally be recharged during wet periods and released slowly from soil during dry periods id all lost to surface runoff.

Stream and river geometry are changed as well. They become widened from increases in stormwater velocity and volume leading to more dramatic floods, disturbance regimes as bank erosion. Embankments become undercut, destabilizing vegetation, and , in turn, exacerbating the erosion problem. This in turn leads to greater sedimentation in the streams, and further toxicities, deposit flooding and stream depth all fluctuating downstream.

The quality of storm water is also degraded. Pollutants are accumulated on paved areas or dumping sites; to then be flushed from these locations during a rainstorm/snow melt. Not only do developed or urbanized landscapes increase the ease at which pollutants can be collected and concentrated, but they also increase their sources. Contaminations may be released through corrosion, decay, oil and fuel leaks, as well as leaching or wearing away of construction materials. Suburban and agricultural areas contribute herbicides, pesticides and fertilizers, which stimulate algal growth and reduce the availability of oxygen in water. This process is call eutrophication and hypoxia; meaning lack of oxygen in a system or eventually reaching the state of a dead zone which lacks all aquatic life that is dependent on oxygen. (Cain, M., W. Bowman, S. Hacker. 2008) Compounded changes in stream hydrology and geometry, combined with reduced water quality, decrease the value of all associated aquatic, stream bank, and flood plain habitats.

Historically, the primary concern in dealing with water runoff was to remove it as quickly from a developed site as possible to maximize local convenience and protection. Traditionally, this was done by conveying runoff by storm sewers, swales, gutters, and channels to the nearest water body, usually stream or river. In a stand alone setting this practice was accepted but when growth and alterations compound exponentially their results become that much more prevalent. Most recent stormwater managements practices have recognized the need for controlling off-site impacts caused by increased runoff velocities and peak discharge rates. The objectives have been twofold: first, to reduce downstream flooding though the use of detention facilities that store and release runoff at a controlled rate and, second, to reduce flooding damage by restricting floodplain development or detrimental modification.

Most legislation at either the state or local level requires that the peak rate of runoff after development cannot exceed the rate prior to development. In some cases the peak development rate must be even lass that predevelopment. But again due to their site-by-site basis these entities are to fragmented to solve any regional flooding problems.

The most recent philosophy with regard to stormwater management concerns the development of a comprehensive, integrated approach that addresses water quality in addition to volume and rate of runoff. (Strom 2004) For a variety of reasons, the sit-by-site approach to storm water management with a heavily reliance on structural measures of agricultural productivity has not been as effective as anticipated. This approach had also fostered the idea that large volumes of runoff are inevitable and unavoidable consequence of site development. This is just like treating a disease rather than seeking a cure. Contemporary practices garner a more proactive and adaptive approach geared more towards prevention and reaction in the face of the modified waterways.

A recent trend in storm system management is watershed-based planning. This approach is viewed as more cost-effective and environmentally beneficial in terms of controlling runoff and protecting water quality. Controlling stormwater runoff at watershed or sub-watershed level through land planning policy, management, and design provides for non-structural and preventative solutions as well as more cost-effective structural methods.

Although the objectives of site-scales management systems have been well intended, they have not adequately addressed downstream flooding or water quality issues such as non-point sources pollution. Detention basins, constructed on a sit-by-site basis, can actually result in increased stream flooding because of possible simultaneous timing of peak discharges from all these basin as well as the possibility of systematic failure as one fails and subsequently proceeds to fail every system downstream. (George 2009). In addition many of the maintenance requirements and associated costs of individual site management systems are rarely considered in the design and implementation. As a result, any of these systems are not properly maintained, further educing their effectiveness.

The development and implementation of a watershed-based management plan require a clearly defined planning process. The first step in this process is to characterize the watershed in terms of flooding, water quality, surface cover, and land use. The second step is to identify, assess and prioritize problems you've discovered. The third step is to establish management objectives for the use of the watershed and identify the non-structural issues, such as land acquisition, impervious cover restrictions, and public education; as well as the structural issues like regional detention measures or other existing entities. The final step is to implement a long-term monitoring and enforcement program. Watershed-based zoning is a land planning tool that has evolved from a number of strategies and techniques. Zoning help establish the intensity of development within a watershed based on some degree on an allowable percentage of impervious cover in relation to specific water quality and stream protection goals.

A debate continues in the Red River Valley in regard to the effect of agricultural drainage on flooding. Many assume drainage of wetlands leads to rapid runoff and exacerbated flooding (Sierra Club 2010). Others argue that ditches lower water tables and increase the efficiency of removing excess water from the landscape, thereby creating drier antecedent conditions that reduce flood potential. Restoration of wetlands at the site will increase the water storage capacity, no question; but how much will storage increase and how will the dynamics of storage (infiltration, rates of runoff from wetlands, evapotranspiration, etc.) ever change? Poor drainage and large groundwater storage capacity within the extensive ancient beach ridges of the Red River Valley may be a key component to mitigating severe floods in the main stem Red River and its tributaries. Elsewhere in the valley the high agricultural value of land precludes wetland restoration for flood control (Shultz, 1999).

How food production systems are designed, managed, and redesigned throughout the world depends on a myriad of social and ecological factors, such as soil type, climate, water availability, pests and pathogens, genetic advances, economic incentives driven by market forces along with policy, and cultural influences including tastes, traditional practices, and urbanization. A key question to be addressed before any discussion of sustainable management can begin is: What are we trying to sustain? Food supplies and adequate nutrition per capita over time? The environmental quality of farm systems and ecosystems affected by food production practices? The cultural integrity of farming communities? Food quality, diversity, and safety? In a directionaly changing world, with continually rising demand for agricultural products driven by population and income growth pressing on a finite land base, trade-offs among these sustainability goals often occur. These trade-offs are likely to become more acute in the future as the demand for biofuels adds to the already large and growing global demand for food and animal feed and as climate change limits agricultural productivity growth in certain locations.

A key feature of resilience-based management is to anticipate change and adjust accordingly in order to preserve long-run ecological functioning and human welfare. Beyond the specific, anticipated sorts of changes in a system, resilience-based management needs to consider the possibility of complete surprises and uncertainties, such as the confluence of events that led to the world food crisis in 2008 (Walker and Salt 2006). There are at least three major transitions confronting global food production systems today that are worth considering in this context: growth in industrial livestock systems, the rising use of crops for fuel, and global climate change. The first two cases can be thought of as demand driven changes, while the third is primarily supply-driven. In all cases, policies directed toward both the agriculture and the energy sectors will play a role in determining the resilience of food production systems.

For Instance, traditionally livestock have been an integral part of agricultural systems, raised close to their food source, and used as an input (soil nutrients and traction) in crop production. In recent decades, however, livestock have become industrialized, often raised far from its feed source and traded internationally (Naylor et al. 2005, Galloway et al. 2007). At the heart of this transition is very rapid income-driven growth in meat demand, particularly in parts of the developing world such as China, Southeast Asia, and Latin America (Steinfeld et al. 2006). In addition, relatively inexpensive feeds, improved transportation, technological innovations in breeding and processing, concerns over food safety, and vertical integration of the industry have led to industrialization and spatial concentration of intensive livestock systems. Urbanization and development of large-scale retail chains further contribute to intensification of these systems (Steinfeld et al. 2006).

A dominant feature of the geographic concentration of livestock—and one that has major implications for the resilience of the sector— is the de-linking of animal production from the supporting natural resource base. Feed is sourced on a least-cost basis from international markets, and the composition of feed is changing from agricultural by-products to grain, oilmeal, and fishmeal products that have higher nutritional and commercial value (Naylor et al. 2005, Galloway et al. 2007). Synthetic fertilizers as opposed to animal manure are used to fertilize crops, and machines are used instead of animal traction to plow the land—both contributing to higher fossil fuel inputs and greater greenhouse gas emissions. The pattern of industrialization is particularly striking for monogastric animals (poultry and hogs), which utilize concentrated feeds more efficiently than ruminants (cattle, sheep, and goats) and which have short life cycles that favor rapid genetic improvements (Smil 2002). Pork and poultry products also tend to be less expensive for developing-country consumers; as a result, industrial livestock production is expected to meet most of the income-driven doubling in meat demand forecast for developing countries in the coming decades (FAO 2004).

The integration of the global agricultural and energy sectors caused by recent and rapid growth in the biofuels market raises even more serious questions than industrial livestock in terms of the resilience of food production systems. Investments in crop-based biofuels production have risen recently around the world as countries seek substitutes for high-priced petroleum products, greenhouse gas-emitting fossil fuels, and energy supplies originating12 Managing Food Production Systems for Resilience 275 from politically unstable countries. Some countries such as the USA are also supporting crop-based biofuels production as a means of rural revitalization. Growth in the biofuels sector raises two important questions concerning the resilience of food production systems. First, can agro-ecological systems be sustained environmentally given the degree of intensification needed to meet biofuels production targets in various countries over time? And second, as greater demand pressure is placed on agricultural systems—and as agricultural commodity prices rise in response—can food security be maintained for the world's poorest populations? In answering these questions, a few trends seem clear. Total fuel energy use will continue to escalate as incomes rise in both industrial and developing countries, and biofuels will remain a critical energy development target in many parts of the world if petroleum prices remain high. Even if petroleum prices dip, policy support for biofuels as a means of boosting rural incomes in several key countries will likely generate continued expansion of biofuels production capacity over the next decade (Naylor et al. 2007c).

A key to enhancing the resilience of food production systems in an era of biofuels will be the emergence of economically and technologically feasible sources of cellulose fuels that can be grown on degraded lands. Current cellulose biomass-to-fuel conversion systems are not yet cost-effective and require large amounts of water (Naylor et al. 2007c). The technology for large-scale deployment of cellulose biofuels production is probably at least 10 years away, although smaller scale biomass systems using more rudimentary technology have long been viable for local fuel production. The coupling of the agricultural and energy sectors at regional to global scales through the development of crop-based biofuels is thus likely to play an important role in the resilience of food production systems for decades to come.

Research Conclusion:

Resilience-based ecosystem stewardship involves responding to and shaping change in social–ecological systems to sustain the supply and opportunities for use of ecosystem services by society. The capacity of ecosystems to supply these services depends on underlying supporting services, such as the supply of soil resources; cycling of water, carbon, and nutrients; and the maintenance of biological diversity at stand and landscape scales. The resilience of these supporting services depends on maintaining a disturbance regime to which local organisms are adapted. Directional changes in these supporting services inevitably alter the capacity of ecosystems to provide services to society. An understanding of these linkages provides a basis for not only sustaining the services provided by intact ecosystems but also enhancing the capacity of degraded ecosystems to provide these services by manipulating pathways for ecosystem renewal.

Both managers and the public generally recognize the value of provisioning services such as water, food, fiber, and fuel wood. It is therefore not surprising that the links between supporting and provisioning services are generally well understood by ecosystem managers and local resource users. This provides a strong local and scientific basis to manage ecosystems sustainability for these goods. In contrast, regulatory services (e.g., the regulation of climate and air quality, water quantity and quality, pollination services, and risks of disease and of natural hazards), although generally recognized as important by society, are often overlooked when discussions focus on the short-term supply of provisioning services. Some of the greatest opportunities and challenges in ecosystem management involve the stewardship of ecosystems to provide bundles of services that both meet the short-term needs of society and sustain regulatory services that are essential for their secure supply at larger temporal and spatial scales. The long-term well-being of society depends substantially on the cultural services provided by ecosystems, including aesthetic, spiritual, and recreational values.

Typological Research

Case Studies

What: What will a large scale master plan look like in terms of not only feasibility but simple graphic representations and data compression into a presentable form.

Example- *Management Concept on the Danube River:* AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS Aquatic Conser6: Mar. Freshw. Ecosyst. 8: 71–86 (1998)

Example - *North Ottawa Impoundment Project,* Grant County, Minn.

Why: Why is this proposal needed here in this area and why at this point in time. Find documented research on the detriment of ecological fragmentation and watershed modification.

Examples- *Hardwood tree decline following large carnivore loss on the Great Plains, USA:* William J Ripple and Robert L Beschta

Where: The Red River Valley is to large an area to synthesize accurately as is all of Richland county; so where exactly will a resiliency plan be most effective in repairing the ecological resilience within the Rice creek Watershed.

Examples- *Tewaukon National Wildlife Refuge*, Richland Co., ND
- *Sheyenne National Grasslands, North Dakota*

How: How, in this political, economical and developmental setting can this resiliency plan be implemented and maintained for the cooperative success of given social-ecological systems.

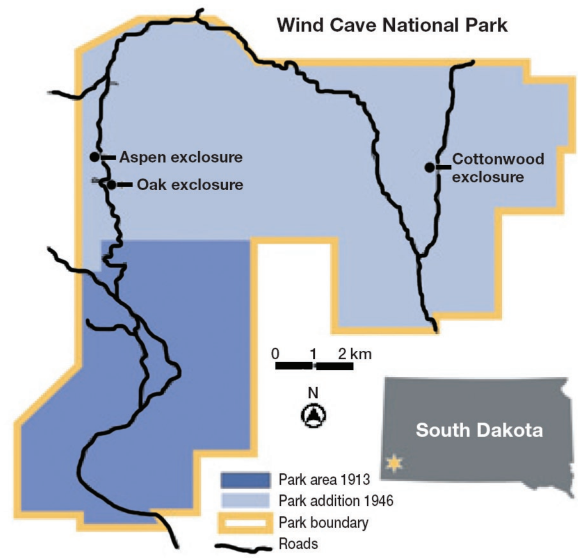
Examples - *Birth of a Megaproject: Political Economy of Flood Control in Bangladesh, Asia Region Technical Department*

Hardwood tree decline following large carnivore loss on the Great Plains, USA

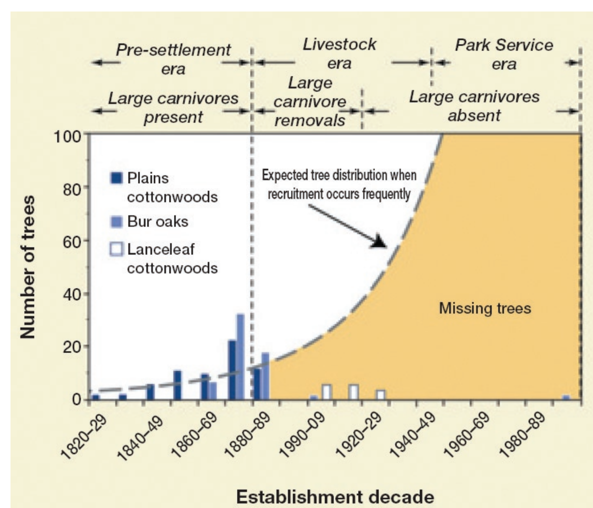
William J Ripple and Robert L Beschta

In order to investigate long-term food web linkages and trophic cascades, College of Forestry, Oregon State University, Corvallis conducted a retrospective analysis of large carnivores, wild and domestic ungulates, human settlement, and hardwood trees from the late 1800s to the present at Wind Cave National Park (WCNP) in southwestern South Dakota. Researchers measured diameters of all cottonwood (Populus spp) and bur oak (Quercus macrocarpa) trees within a large portion of the Park to assess long term patterns of recruitment (growth of sprouts or seedlings into tall saplings or trees). Increment cores from a subset of these trees were used to determine tree age and to develop relationships between age and diameter. Resulting age structures indicated a complete lack of cottonwood and bur oak recruitment for more than a century, beginning in the 1880s and continuing to the present. This is attributable to high levels of browsing, initially by livestock and subsequently by wild ungulates, in the absence of large carnivores. Conversely, we found that hardwood trees had recruited to areas protected from browsing, such as inside fenced enclosures and within a small browsing refuge. Results indicate that Great Plains ecosystems may have been profoundly altered by mounting levels of ungulate herbivory following the removal of large carnivores.

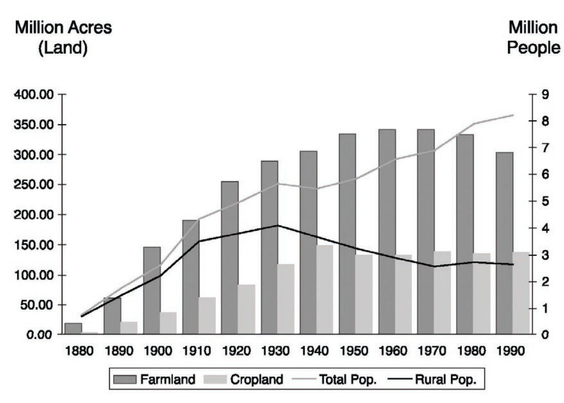
Along with these observations a number of subsequent fallouts can be seen exemplify the theory of top down regulation of ecosystems. The fact that Red Osier Dogwood (Cornus stolonifera), Serviceberry (Amelanchier spp), and sapling Aspens (Populus tremuloides) are found only in secluded and inaccessible areas, combined with the fence-line differences in buffaloberry (Shepherdia canadensis) and bearberry (Arctostaphylos uva-ursi) numbers, suggest that browse utilization in the study area is intense.



Map of Wind Cave National Park in southwestern South Dakota. Our study area comprised the entire northern part of the Park (light blue). This 66.2 km^2-area was originally the Custer Recreational Demonstration Area, added to the Park in 1946.



Estimated tree establishment dates in WCNP study area for plains cottonwood, cottonwood, and bur oak trees growing outside of fenced exclosures. Few trees have originated since the 1880s. The dashed line shows the expected pattern of tree numbers if recruitment occurred from the 1880s to the present. With natural stand dynamics, there should be exponentially more small young trees than large old trees (Beschta 2005).



Population, Land Use, and Environment: Research Directions. National Research Council (US) Panel on New Research on Population and the Environment; Entwisle B, Stern PC, editors. Washington (DC): National Academies Press (US); 2005.

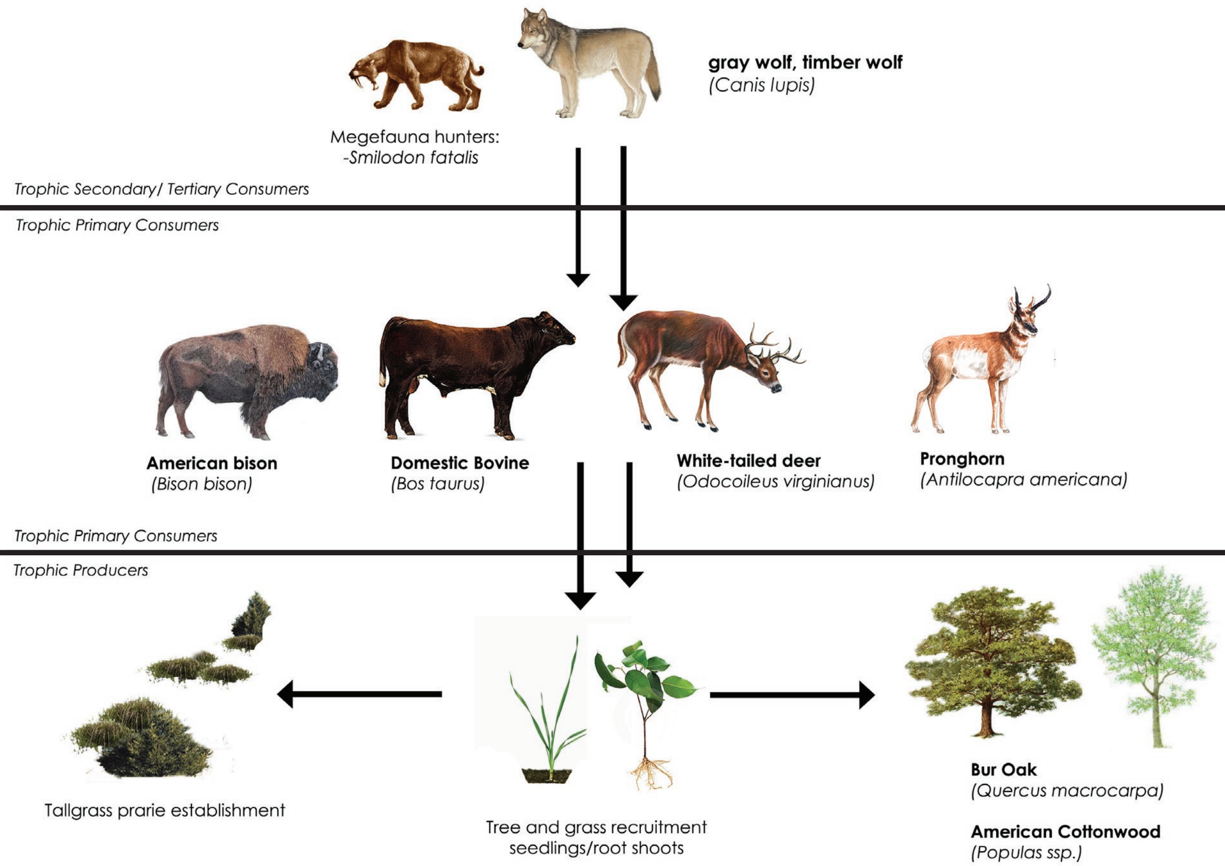


Image: Showing trophic cascade, in graphic form, as a result of the loss of large predators on the Great Plains as well as a lack or recruitment by important tree species i.e. Bur Oak, and American Cottonwood. ** image built by Patrick Corrigan (NDSU)

It is also noteworthy to contrast the contemporary abundance of coyotes and absence of wolves with the lack of coyotes and abundance of wolves. While beaver colonies currently exist outside WCNP on National Forest Service lands, there have been no active beaver colonies documented in WCNP since the early 1900s (B Muenchau pers comm). Since high-density ungulate populations can heavily browse woody plants in riparian areas, thus reducing forage available to beaver (Baker et al. 2005), the present lack of beaver within WCNP – which contrasts starkly with the abundance observed by Custer in 1874 – may well be a result of ungulate browsing.

As resource mangers we realize early that we can never truly control a systems ecology; mostly due to the fact that we can never consider every intricate evolutionary refinement that has integrated mutually within a biological system. These processes are the result from millions of years of evolutionary refinements and even our smallest footprint into them can cause drastic effects both up and down a trophic scale. However this is not to of the opposite scenario; it takes a massive effort and years of intense management to restore or simply stabilize and collapsing ecosystem. The legacy of human disturbances and alterations leading up to the present provided a necessary context for the realistic evaluation of ongoing effects.

Tewaukon National Wildlife Refuge

Tewaukon National Wildlife Refuge, Comprehensive Conservation Plan. U.S. Fish and Wildlife Service, Region 6. Septemebr 2000.

The Refuge was established in 1945 to provide a resting and breeding place for migratory birds and other wildlife. The 8,363-acre refuge has two units, Tewaukon and Sprague Lake. The Tewaukon Wetland Management District, established in 1960, is also managed from the Refuge headquarters. The District includes over 14,000 acres of Waterfowl Production Areas, 35,000 acres of wetland easements, and more than 20,000 acres of grassland easements located throughout Sargent, Ransom, and Richland counties.

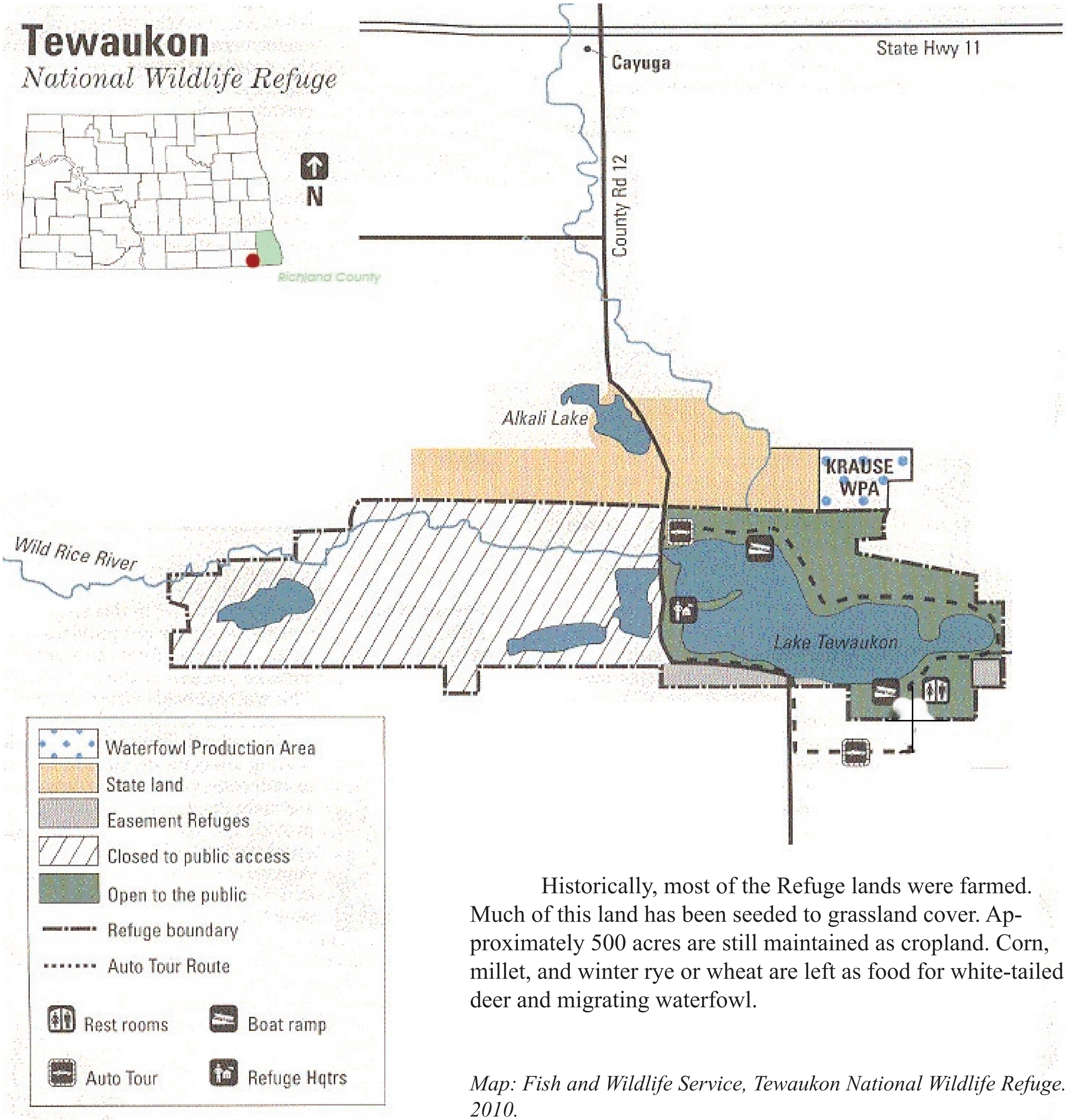
What is unique about the Tewaukon National Wildlife Refuge (NWR) is that its located in southeastern North Dakota and is situated on the western edge of the northern tallgrass prairie. The Refuge is located astride the Wild Rice River, which flows west to east then north out of Lake Tewaukon and into my desired management watershed the Eastern wild Rice watershed. Tewaukon NWR is also located in the Prairie Pothole Region; the density of wetlands in this area make it one of the most biologically productive systems on the continent.

Because this refuge is located within the proposed site, all drainage systems and ecological process must not be interrupted or damage in the facilitation of a larger management plan. This exemplifies the management approach that I wish to take based on where these crucial biological centers are and how they foster biological diversity and serve as hydrological stabilizers at the same time.

Refuge wetlands, prairies, grasslands, and stream corridors provide wildlife with diverse habitats that meet their needs. East meets west at Tewaukon NWR. Birds commonly associated with eastern woodlands and birds common in Midwestern grasslands are found here. During the course of a year, over 243 different bird species use Refuge habitats.

Wetlands on the Refuge come in a variety of sizes and depths. Temporary and seasonal wetlands fill with water in the early spring from snowmelt and are usually dry by mid-summer. These smaller wetlands provide important food resources for migrating birds and pair habitat for breeding ducks.

Larger, more permanent wetlands usually hold water year-round unless drought conditions exist. Waterfowl, wading birds, marsh wrens, muskrats, mink, leopard frogs, and painted turtles are a few of the species that depend on Refuge wetlands.



Historically, most of the Refuge lands were farmed. Much of this land has been seeded to grassland cover. Approximately 500 acres are still maintained as cropland. Corn, millet, and winter rye or wheat are left as food for white-tailed deer and migrating waterfowl.

Map: Fish and Wildlife Service, Tewaukon National Wildlife Refuge. 2010.

Management Concept on the Danube River

AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS
Aquatic Conser6: Mar. Freshw. Ecosyst. 8: 71–86 (1998)

K. TOCKNER, a, F. SCHIEMERa and J.V. WARD, b.
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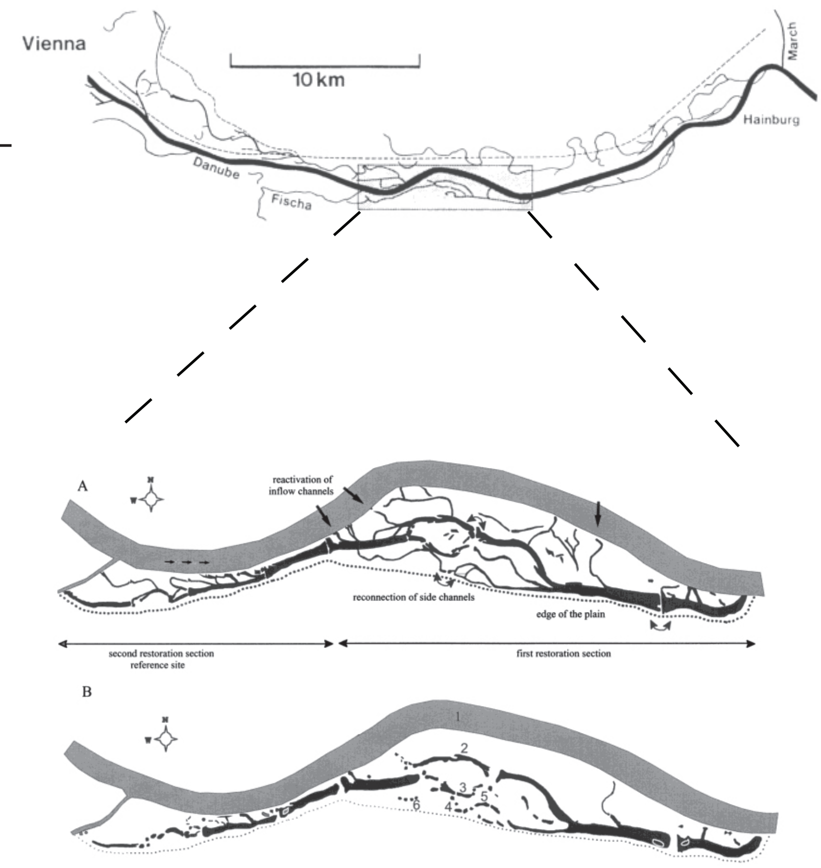
b Department of Limnology, Swiss Federal Institute for En6ironmental Science and Technology (EAWAG:ETH), U8 berlandstrasse 133, CH-8600 Du¨bendorf, Switzerland

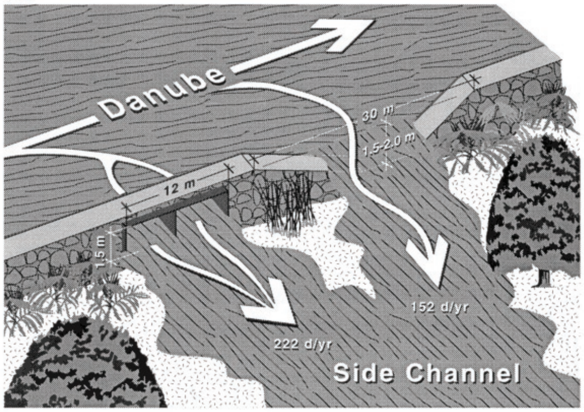
One of the last remnants of a functional alluvial landscape on the Danube River located in Austria, extends from Vienna to the Slovakian frontier. It is recognized as an ecosystem extremely worthy of protection and therefore has been designated as a National Park (‘Alluvial Zone National Park’). However, surface connectivity has been reduced and floodplain habits have been fragmented. At present, lateral exchange processes of nutrients are restricted to short-term flood pulses, while most of the year backwater processes are de-coupled from the river system. A very high species diversity is recorded for this section, with a high proportion of endangered species in all groups, ranging from 16% for riparian vascular plants to 100% for amphibians and reptiles.

A large-scale pilot project has been developed for a segment of the free-flowing section of the Danube to restore gradually the hydrological connectivity between the river and its floodplain. This concept has been developed in cooperation with the Federal Waterway Agency (Wasserstrassendirektion Wien, WSD) and the Committee of the National Park, and both scientists and engineers assume responsibility for this project. This study describes the ecological fundamentals, based on status quo investigations, and the guidelines that form the basis for planning such a large-scale restoration scheme. It is proposed that these results and experiences could provide the basis for long-term, adaptive management of modified river-floodplain ecosystems.



25 km downstream of Vienna on the orographically right bank of the River Danube, land is in the public domain (National Forest Authority) or is held in trust by WWF-Austria.

A



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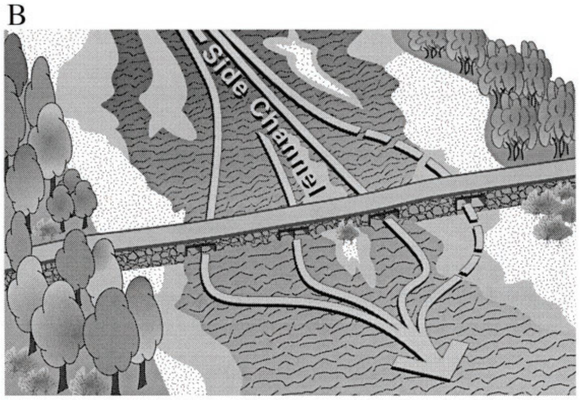
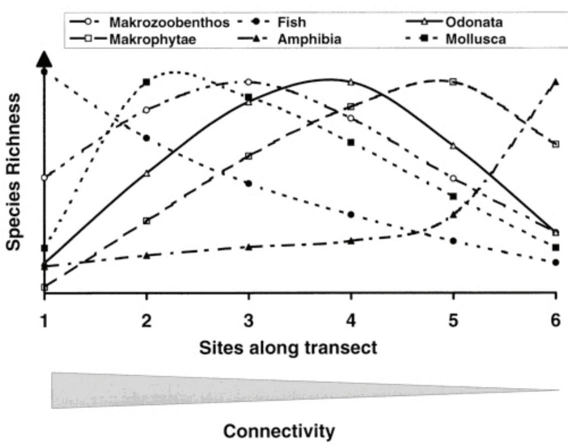




Species numbers (with relative proportion of endangered species %) of selected groups identified for the river-floodplain area between Vienna and the Slovakian border (updated from Tockner and Schiemer, 1997)

Taxon	Species (endangered %)
Riparian vascular plants	623 (16)
Aquatic macrophytes	57 (50)
Mollusca (aquatic/semiaquatic)	79 (86)
Odonata (dragonflies)	49 (43)
Trichoptera (caddisflies)	53 (17)
Coleoptera (aquatic beetles)	34 (?)
Amphibia	12 (100)
Reptilia	7 (100)
Fish	54 (48)
Birds (including migratory species)	164 (—)
Birds (breeding species)	94 (29)

The Danube River, once famous for its large inundation areas, has undergone a fate similar to that of most large rivers in temperate Europe and North America; The Danube has been channelized, confined by levees, impounded, and polluted (Schiemer and Waidbacher, 1992). To fix this the main technique implored by management officials was the idea of side-arm system and owbow-tributary inter connectivity.

The side-arm system will be reconnected to the Danube by lowering parts of the riverside embankment (length at each site: 30 m) and by the creation of artificial openings. Embankments will be lowered at one site down to mean water levels well as surface connections via artificial openings occurring at lower levels. After implementation, the side-arm system will be re-integrated into the flow regime of the river for more than half of an average year. To improve the rate of discharge through side arms, existing dams crossing side-arms and dividing them into single sections will be completely removed and additional outlets will be created.

The free-flowing section of this river is suitable habitat for more than 80% of the fish species occurring in Austria, and for two-thirds of all dragonflies and about one third of the caddisflies. For the floodplain area in this free-flowing section (excluding the main channel) 447 benthic invertebrate species have been recorded, which is about 50% of all species presently known for the whole Danube in Austria (Moog et al., 1995). Species richness is about three times higher than in a comparable floodplain. The high proportion of endangered species in the free-flowing section reflects the general deterioration of riverine habitats due to pollution, river regulation and damming, and demonstrates at the same time that immediate action is called for to create an international preservation network for the last large free-flowing river systems sections.

North Ottawa Impoundment Project

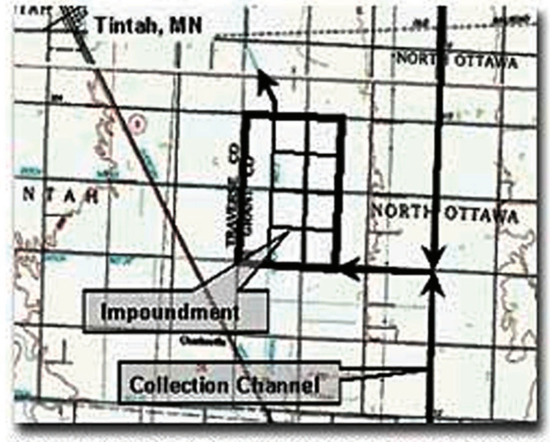
Grant County, Minn.

The North Ottawa Section 206 project is located in western Minnesota, approximately 25 miles southeast of Breckenridge, Minnesota, in North Ottawa Township, Grant County.

The project is part of a larger project of the Bois de Sioux Watershed District. The watershed district is constructing an impoundment for flood damage reduction. The Corps of Engineers is proposing to build structures within the impoundment to restore habitat for migrating waterfowl.

The preliminary restoration plan is prepared at full Federal expense. All remaining costs for planning, design, and construction will be cost shared at 65-percent Federal and 35-percent non-Federal if the project is approved and proceeds to construction. (Army Corp., 2011)

Federal funds allocated to date: $633,000



Map of the North Ottawa Impoundment project

HTTP://WWW.MVP.USACE.ARMY.MIL/WEBIMAGES/96PHOTO.JPG

Project Benefits:

Flood Damage Reduction (Primary objective): Provides 16,000 acre feet of gate-controlled storage which is equivalent to 75% of the estimated 100 year spring runoff.

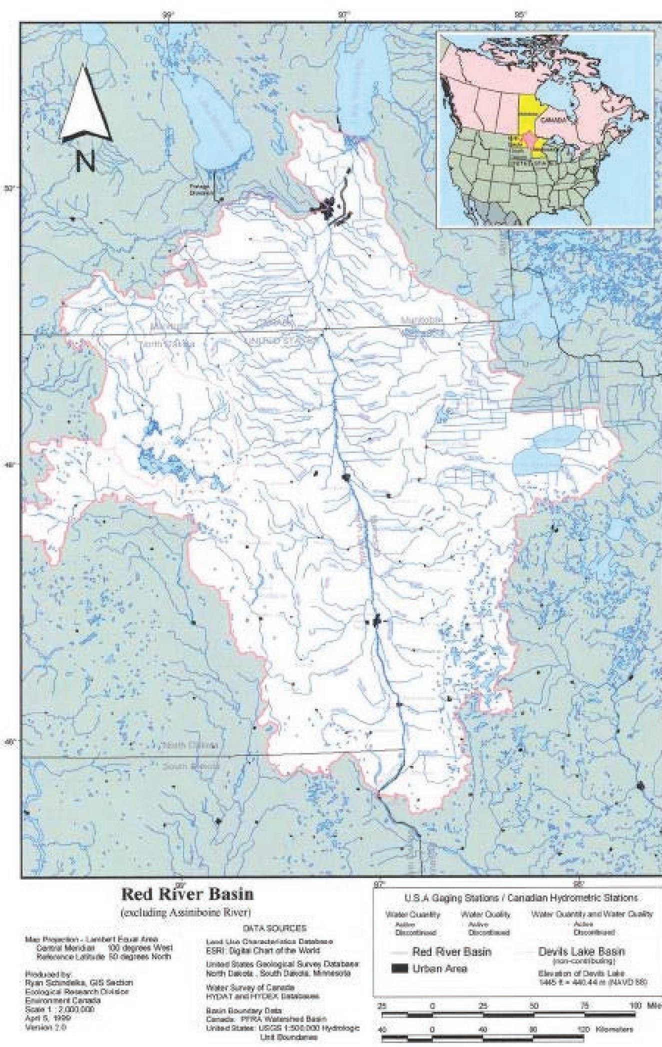
This is expected to reduce peak flows on the Bois de Sioux River at Wahpeton/Breckenridge by about 5%.

Downstream Flow Augmentation: Release of about 5 cfs flow during the ice free season in most years.

Water Quality: Improvement via sedimentation and nutrient uptake by wetland plants

Habitat Enhancement: Feeding and resting areas for migrating waterfowl and shorebirds and stream flow maintenance for downstream fish habitat.

**Army Corps of Engineers, 2011

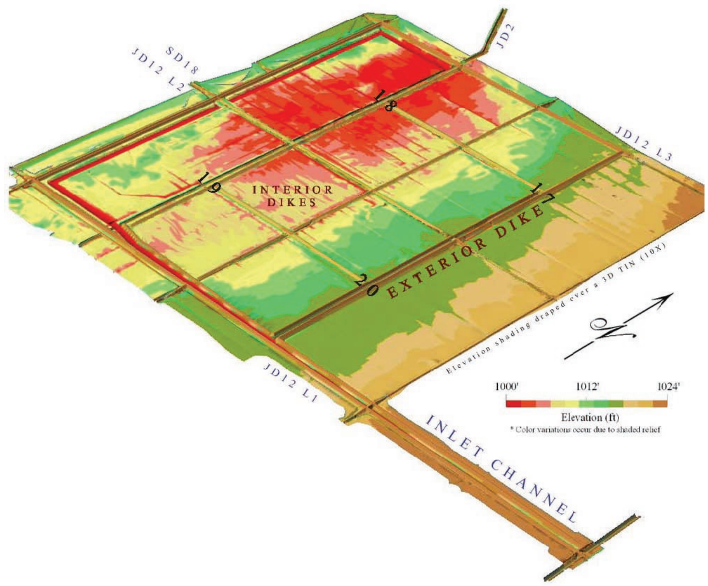


** Roeschlein, Jon. 2005.

Ecological resiliance benifits

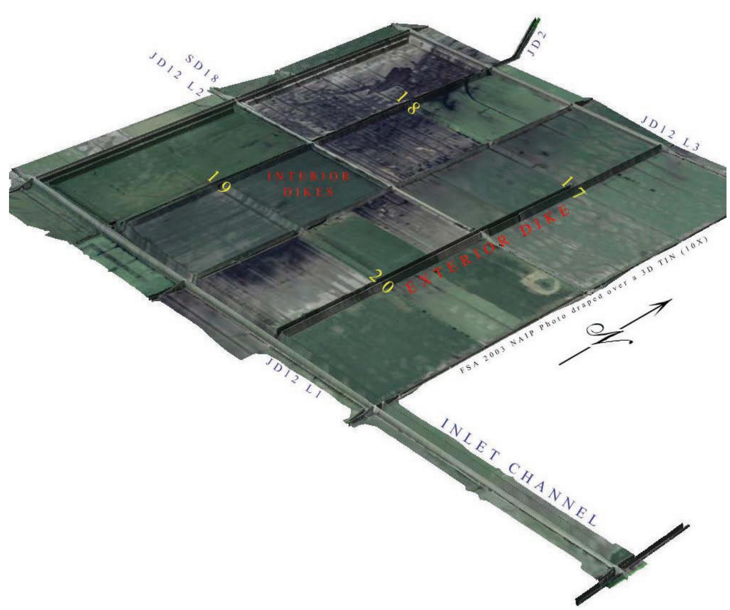
The Corps project would allow management of the stored water to provide a variety of environmental benefits. Internal dikes and water control structures would divide the impoundment into smaller pools to maximize flexibility for natural resource management. The project would provide wildlife habitat and recreational opportunities, moderate the streamflow hydrograph, control sediment, and improve water quality.

The greatest expected environmental benefits would come from the creation of feeding and resting areas for migrating shorebirds and waterfowl. The pools would be managed to continually provide newly exposed mud flats and shallow flooded areas in which shorebirds feed. Waterfowl would be attracted to the newly flooded shallow areas to rest and feed on annual plants. (Army Corp., 2011)



**Included images courtesy of :

Roeschlein, Jon. 2005. North Ottawa Impoundment Project. Watershed District presentation, September 20, 2005. Bois de Sioux Watershed District Administrator.



Sheyenne National Grasslands

Forest Service of the United States Department of Agriculture,

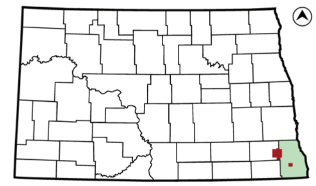
Soil Conservation Service, the Forest Service, and the Sheyenne Valley Grazing Association

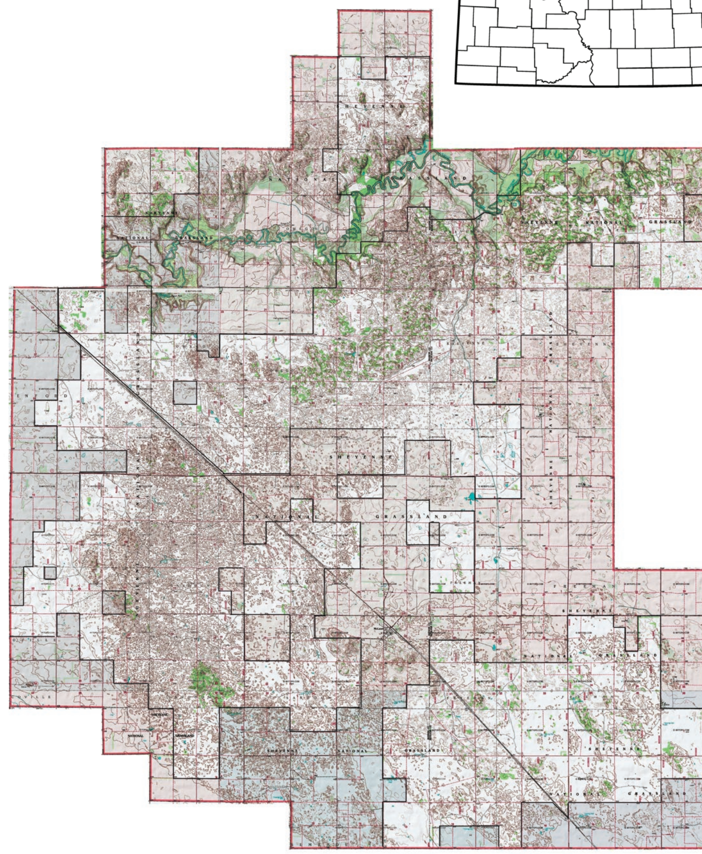
The Sheyenne National Grassland is an area of approximately 70,250 acres of public land associated with 64,769 acres of privately owned land in Ransom and Richland Counties, North Dakota and is the only remaining tallgrass prairie in public ownership in the United States. Of 1,200 plant species in North Dakota, 850 can be found on the Sheyenne Grasslands, such as the threatened western prairie white- fringed orchid and the beach heather. Other populations of the western prairie white-fringed orchid exist, however the population found in the grasslands is one of the largest known to exist.

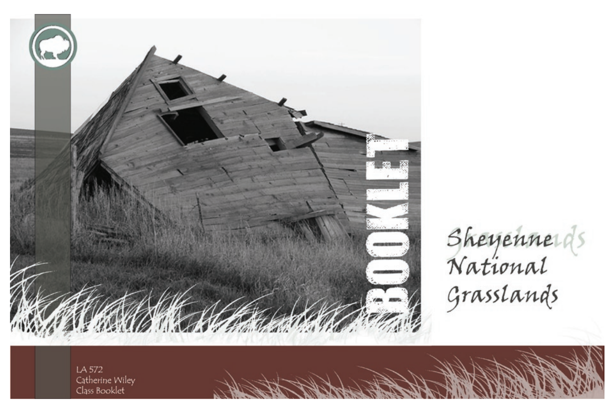
U.S. prairie systems are among the most degraded of all ecosystems and have experienced substantial changes in species composition, species diversity, and ecological succession patterns, particularly since fire suppression policies have been in effect. Land managers are faced with re-introducing fire into landscapes that are very different than they were before fire exclusion, hence the detailed burn schedules and plans included into the management areas. All done towards re-establishment of desirable, native, functional plant species and eradication or control of undesirable, exotic, or invasive species.

To mitigate the consequences of the ‘dust bowl’ conditions on the land and its residents, the Sheyenne River Land Utilization Project was established in 1935 under the AAA (Agricultural Adjustment Administration), and a resettlement plan for the area was completed that same year. In 1937 the Bankhead-Jones Farm Tenant Act provided for the acquisition of the submarginal farm lands, and administration of the Land Utilization Project passed from AAA to the Resettlement Administration. In 1938 administration of the Project was transferred to the SCS (Soil Conservation Service), whose charge was to insure the rehabilitation of the drought-devastated grasslands.

What makes the Sheyenne National grasslands so unique and successful is its management program of fire burns, invasive species control and most importantly their cooperative land management strategy for ecological restoration.







Much of the data and information drawn from the national grasslands was gathered during a three month study for graduate work at North Dakota State University, in the Landcape Architecture Department (LA 571: Fall Semester 2010). End reult being a management plan for ecological restoration and tourism recreation within the national grasslands. (NDSU, Landcape Architecture 571)

In 1941 at the urging of the SCS, the local landowners formed the Sheyenne Valley Grazing Association, a nonprofit organization whose members desired to graze cattle on the surrounding federal land. Members of the Association invested much time and many dollars to re-establish vegetative cover on the land and to change land use practices. In 1954 with the rehabilitation job essentially complete, administration of these lands was again transferred, this time to the Forest Service. The project was first assigned to the Chippewa National Forest and, finally, to the Custer National Forest on June 1, 1966. The Sheyenne River Land Utilization project was formally named the Sheyenne National Grassland in 1960.

The National Grasslands are now publicly owned lands administered by the Forest Service of the United States Department of Agriculture. These large blocks of land in North and South Dakota are the home of four Ranger District Offices; the Grand River Ranger District Office on the Grand River and Cedar River National Grasslands; the Sheyenne Ranger District Office on the Sheyenne National Grasslands located in Ransom County; and the McKenzie Ranger District Office and the Medora Ranger District Office on the Little Missouri National Grasslands.

The National Grasslands are not solid blocks of National Forest System lands; rather, they are intermingled with other federal, state, and privately owned lands. This mixed ownership pattern contributes to the uniqueness of the National Grasslands. The Northern Region area encompasses 25 million acres and is spread over 5 states. Included are 12 national forests located within the perimeter of northeastern Washington, northern Idaho, and Montana; and the national grasslands in North Dakota and northwestern South Dakota.

The Sheyenne National Grassland of today presents a sharp contrast to the grassland condition of the 1930's. The federal repurchase and resettlement programs, and the rehabilitation and management efforts of the Soil Conservation Service, the Forest Service, and the Sheyenne Valley Grazing Association have ushered the lands from a condition of windblown dunes and farmlands to well-grassed, productive, and functional rangelands.

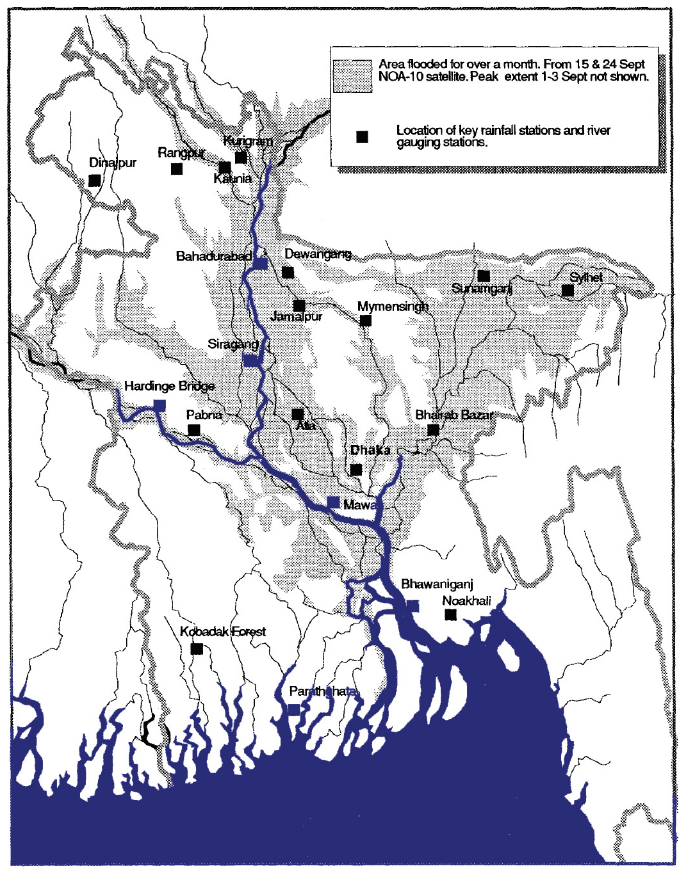
Birth of a Megaproject:

Political Economy of Flood Control in Bangladesh

The International Bank for Reconstruction and Development/THE WORLD BANK (1990), and The Asia Region Technical Department.

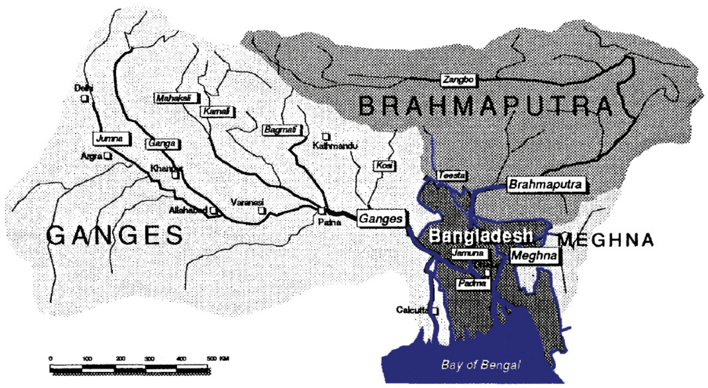
Bangladesh, with an area of around 144,000 km2, experiences flooding every year on up to two-thirds of its territory. During the monsoon months (Jun-Sep), when 80% of annual rainfall occurs, the Ganges, Brahmaputra, and Meghna Rivers bring about 1×10^{12} m^3 of water plus 500 to 1500 Metric Tons of sediment into Bangladesh from the upstream catchment area (area 1.74 million km2).(source PDF). Normal annual flooding provides numerous benefits - common access to the large natural floodplain fishery, deposition of fertile loam on agricultural fields, and flushing of stagnant water in low-lying areas. But when the major river flood peaks coincide, unusually high floods can occur, causing catastrophic losses - damage to crops, housing, and infrastructure, and increased incidence of disease and death.

FLOODS OF SEPTEMBER 1988



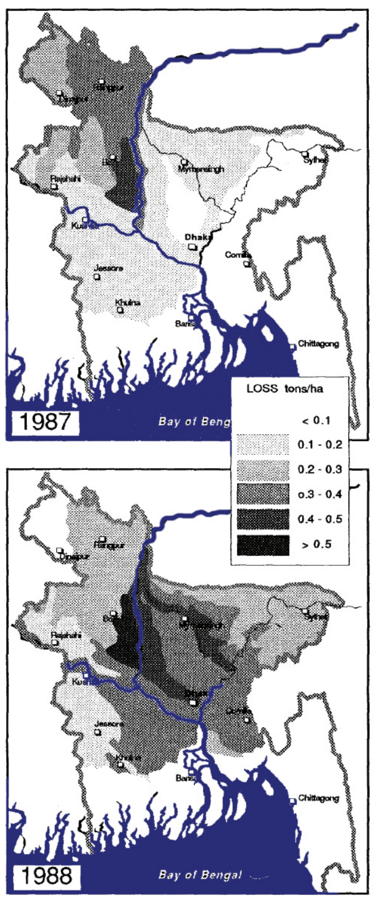
Population has increased from about 70 million in the early 1970s to about 130 million in 2000, with 172 million forecast for 2025, even though population growth has been significantly reduced in recent years. Over 80% of the population lives in rural areas, and over half still depends on agriculture for livelihood. Increasing population density and agriculture dependence compels people to inhabit floodvulnerable areas, intensifying flood impacts and placing severe constraints on flood control options. To cope with these challenges, over the past several decades water resources planning has evolved in three phases: national water planning, the Flood Action Plan (FAP). (Megaproject)

In the end FAP was strongly opposed by local and international NGOs, organized around a coalition of environmental NGOs that initially raised awareness through public meetings outside Bangladesh. In the end, the FAP did not recommend large-scale works; rather, it initiated guidelines on people's participation and environmental assessment.



THE GANGES, THE BRAHMAPUTRA AND THE MEGHNA BASINS

LOSS OF MONSOON RICE PRODUCTION



- In 1964, a national (at that time provincial) water planning approach was initiated with the 20-year Water and Power Master Plan. Though this Plan did lead the way to protecting most of the coastal zone from tidally-induced flooding, overall it was too ambitious, overestimating public sector capabilities and overemphasizing large-scale surface water interventions.

- In 1986, Phase I of the National Water Management Plan (NWP) was completed. This time around, planners emphasized ground water development for irrigation, mindful of the weak performance of existing flood control. The Government, concerned about possible overestimation of ground water, did not accept this plan.

- In 1991, NWP Phase II was completed, including a detailed investment program. It was overtaken by events when severe flooding in 1988 led to the formulation of the Flood Action Plan.

It is now widely accepted that planning must be participatory and that consultation at all levels is essential to correctly identify development needs and interventions. Furthermore, greater emphasis on participation has led to the recognition that as people's lives are not compartmentalized by sectors, so too must planning be multi-objective and multi-sectoral.

To this day a cumulative acceptance has not been reached and the challenge still remains; will be be able to put these lofty principles into practice in the field. Progress is likely to be slow, given public sector capacity limitations.

Other outcomes of the flood plane's downfalls included:

- Much greater emphasis in the planning process on environmental and institutional aspects,
- Flood mitigation as an integral part of flood management, acceptance that flood control should be addressed in a regional context,
- Cooperation among riparian countries is essential.

Results from Typological Research

A number of successful practices for managing resilience in a ecological biome can be deduced from these case studies; as well as an understanding of assessment techniques regarding existing ecological conditions that contextually influence a site.

First is the fact that despite the massive regime shift that can be seen as a result of systems fragmentation, we often neglect the more subtle of shifts in natural systems which can have as much if not more effect on a habitats resilience. Keystone species and trophic cascade are important issues to address and analyses in this area's management plan.

Second, approaches to developing and implementing a large scale hydrological restoration in any given area across the globe. The setbacks in Bangladesh's FAP, illustrate how to design with both social and environmental conditions in mind and to not over exceeded an area's potential or willingness to adopt change. Contrasted to the success in preserving a vital and biologically rich area along the Danube Rive in Austria. Their assessment technique for ecological and functional resilience in these systems helped create and implements a developmentally minimal plan that is mutually beneficial to private entities and environmental preservationists.

Lastly, is the understanding of current methodologies and environmental mentalities that resonate in this area of the Great Plains. Large scale management areas like the Sheyenne National Grassland and the Tewaukon National Wildlife refuge embody the desire people in this region have to preserve the natural environment and ensure its stewardship for future generations. These areas are now the only remaining ecological areas large and/or resilient enough to continue the functionality of dominant natural systems that once stretched across the entire Midwest.

With more and more issues of ecological fragmentation and degradation being seen in countless social-ecological systems throughout the Red River Valley and the Great Plains; there is no doubt certain management practices should be consolidated to start repairing the most degraded and failing systems. With dominant ecological hubs and large land preservation all within the proposed manageable watershed (supplementary analysis), connecting these areas will help immensely with disconnections and breaks in even larger natural systems like bird migration at flight path, wildlife populations if endangered and ecologically important populations, and overall diversity and resilience in this corner of North Dakota. The areas naturalist culture is the ideal backdrop for implementing a new land development methodology, however overestimation has been a common downfall, meaning all modifications to all effected people and/or entities must be done so-operatively and not imperially.

Now a properly scaled and detailed watershed management plan can begin to be formulated. With programmatic goals and proper assessment techniques adequate researched, a general site inventory and analysis can start in areas and on levels that most dominantly pertain to a modern hydrological restoration project of this size.

History in the Red River Valley

A Brief History on Migratory Bird Protection in the US

The culmination of years of careful development and management has created a environmental protection system within this country, specifically in regards to wetlands and waterways, that is self sustaining and enforced by political laws and regulations. One of the most effective conservation programs that's greatly unknown is the Small Wetlands Program, this existing program uses monetary funds from the sale of Federal Duck Stamps to permanently protect some of the most threatened and productive migratory bird habitat in the United States. Since its creation 50 years ago, the program has protected nearly three million acres of habitat, mainly in the Prairie Pothole Region of the United States. These protected areas are called waterfowl production areas, and they are part of the National Wildlife Refuge System. While the Small Wetlands Program is arguably one of the most effective and efficient conservation programs in the history of the United States, it is also a marketing nightmare. It has a complex and sometimes confusing legislative history, its funding comes from multiple sources, and numerous service programs play a role in its operation; the program itself includes many subsets. Waterfowl productions areas, wetland management districts, wetland acquisition offices, and habitat and population evaluation teams are just a few of components that keep this program running.

The original conception of environmental protection toward migratory birds started around 1885 with the creation of the Bureau of Biological Survey. This is the beginning of what will later become the Fish and Wildlife service in the US and was born from conservation pressures for our nations wildlife from organizations like the American ornithologist Union and the USDA. The growing fashions in the 1880s and 1890s sported hats adorned with real feathers and stuffed wild birds. The bird feather trade took a great toll harvesting some 200 million wild birds per year by some estimates (USFWS 2007). yet in 1890 came the Model Law which distinguished game birds and non-game, "Song" birds as well as introducing hunting laws and private habitat protection. Soon after that came the Lacey Act of 1900 which was one of the major federal laws to regulate wildlife. Due to increased market hunting in new lands opened by the Paris Peace treat and the Louisiana purchase one of the best means for controlling wildlife harvesting was to restrict newly named "illegal" game shipments across state lines (meat, feathers, pelts, ect.) In 1913, Congress followed it with the Weeks-McLean Migratory Bird Law, which placed migratory birds under federal jurisdiction and prohibited their killing without authorization from the federal government. The most important stipulations included: outlawed hunting of game birds in spring migration, secretary of Agriculture establishes closed seasons on migratory birds, and the Biological survey is in charge of enforcement (weak and underfunded as it is). Many state and federal courts lashed out at the 1913 law as a 10th Amendment violation. Most likely fueled by social and political wake of the New Deal.

The next 5-6 years sees a series of court cases and conflicts concerning the oppression placed on hunters by the federal government. The Us finally finds a solution in 1918 with the Migratory Bird Treaty between American and Great Britain concerning the bird flyways that span the entire continent. This is an agreement by to sovereign nations that goes beyond an individuals congressional amendments and greatly solves the discontent over regulation and control. To solidify this Congress can now pass the Migratory Bird Treaty Act of 1919 to federally enforce the treaty and set technology use, seasons, bag limits, and species options. As agriculture spread, spurred by expanding railroads, people began to notice environmental effects from wetland drainage, i.e, lowering water tables, decline in fish populations, and an overall reduction of income from hunting and fishing. Meanwhile there are people like Fredrick Lincoln who are exploring the us mapping dominant flyways (Central Atlantic, pacific and the Mississippi), or Peter Norbeck who reported on habitat conditions and advocated bird banding for migratory tracking. Finally the Norbeck-Anderson Migratory Bird Conservation Act was passed in 1929 to provide federal funding for land surveying and purchasing land for refuges in important flyways. Now in early in 1934 President Franklin D. Roosevelt appointed Jay "Ding" Darling, Aldo Leopold, along with Tom Beck, editor of Collier's magazine, to what became known as the Beck Committee to study dwindling waterfowl numbers and how to restore them. One of their creation was the Migratory Bird Hunting Stamp act in 1934 as a required yearly stamp for hunters who's money is then pooled to expand the refuge systems put in place by Rosevelt. To augment this with further capital support in 1937 the Pittman-Robertson Act is signed to tax all sales of guns and ammunition. After this most conservation programs are sustainably integrated into America's social and political structure allowing for continued dedication to the refuge program and wetland habitat protection.

USFWS, US Fish and Wildlife Services, The Small Wetlands Program: (Washington DC: U.S. Fish and Wildlife Service , 20010).

Red River valley Historic events predating 1900

1730's:
The first European explorer to reach the Red River Valley was the French voyageur, Pierre Gaultier de Varennes. He reached the Red River in 1732 and established a series of posts in the area, including Fort Rouge on the present site of Winnipeg.

1811-36:
The first permanent settlement by Europeans in the Red River Basin was founded on the banks of the Red River near the mouth of the Assiniboine River (in present-day Manitoba).

1812
Several Scottish families emigrated to the area. They became the first permanent settlers to farm in the Red River Valley. They built the first known man-made dam in the Red River Basin, near present day Winnipeg, Manitoba.

1818:
The Red River Valley below the 49 degree of North Latitude became a part of the United States by treaty with Great Britain. The Red River Valley portion of North Dakota and Minnesota did not become a part of the United States by way of the Louisiana Purchase of 1803.

1820-1850's:
Development of the Red River Ox Carts The flat plains and uniquely designed ox carts made it much easier and cheaper to supply the Red River Valley settlements from Minnesota than from eastern Canada.

1858:
Minnesota became a state. Its western boundaries were cut back from the Missouri River to the Red River.

1859-1871 Steamboat Era:
Steamboating on the Red River lasted 53 years, with steamboats carrying a variety of trade goods on the Red River.

1860's:
Decline of the fur trade in the Red River Valley begins.

1862:
The Homestead Act was passed by the U.S. Congress, giving title to 160 acres of unoccupied public land to each homesteader on payment of a nominal fee and required five years of residence. This legislation opened up the Valley to a flood of pioneers who turned to wheat farming.

1867:
British North America Act, giving Canada self-governing authority.

1871:
Railroads reached the Red River from St. Paul and Duluth, Minn., providing a vital trade link between the Valley and St. Paul, and further opening the basin to settlement. The railroads influenced development of the Red River Valley by selling vast acres of railroad lands, and by much promotion and advertising of the area.

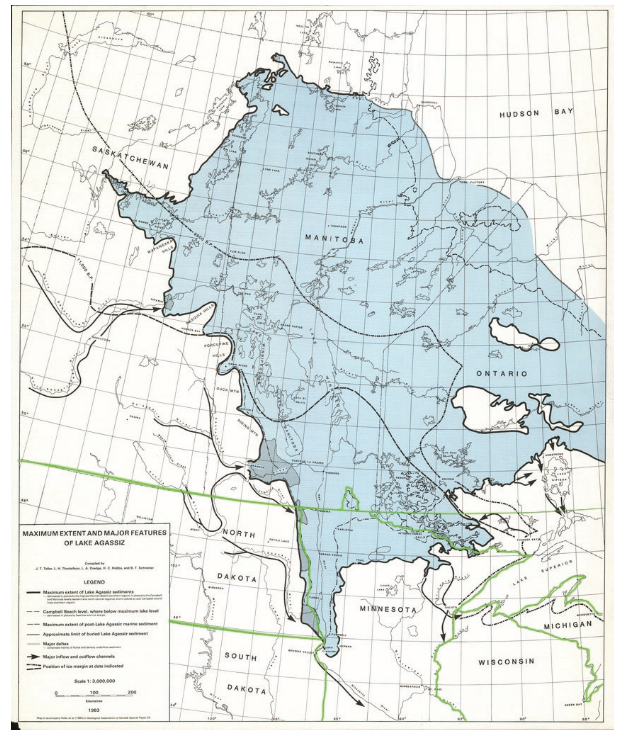
1871-1886:
The era of Red River Valley "bonanza farms." Many bonanza farms had thousands of acres under the plow. This was also the era of a boom in settlement which saw the population increase almost sixfold.

1889 :
Dakota Territory was divided, and both North and South Dakota were admitted to the Union on Nov. 2, 1889.

Dates and Information Proveided by: River Keepers. "Promoting a renewed vision for the Red Rover of the North." Cass & Clay County Historical Society. 2010. Dec. 9, 2010. <http://www.riverkeepers.org/>.

Historical summary of magament Influences

30,000 years ago began the geographic shaping we see today during the ice age period called the Wisconsin Glaciation. This period brought the glaciers south across much of present Canada and the northern parts of the present day United States. Around 12,000 years ago the glacial period was ending and they slowly retreated north. The land area left over contained much of the glacial melt and precipitation of the time. This was called Glacial Lake Agassiz, named after Louis Agassiz (1807-1873), the father of glacial geology. (Bluemle, J.P., 1997). At different times in its life, the water body encompassed much of Manitoba and western Ontario, northwest Minnesota and eastern North Dakota, as much as 365,000 square miles. The southern tip is where Wahpeton North Dakota and Breckenridge Minnesota currently sit. Water always flows downhill, in this region downhill is actually to the north. As the glaciers melted between 12,000 and 9,000 the lake slowly drained as drainage outlets to the north which were blocked off by the glacier were opened up as it melted. The Red River Valley is a young river valley in geologic terms. It starts at the meeting of the Ottertail and Bois de Sioux rivers at Wahpeton, North Dakota. The channel is digging the land out and slowly going deeper and deeper. The land around it, the old lake bed, is very flat, sometimes with only one foot change in elevation per mile. There is only a drop of 233ft of elevation from Wahpeton, North Dakota to Winnipeg, Ontario. (GIS data layer).

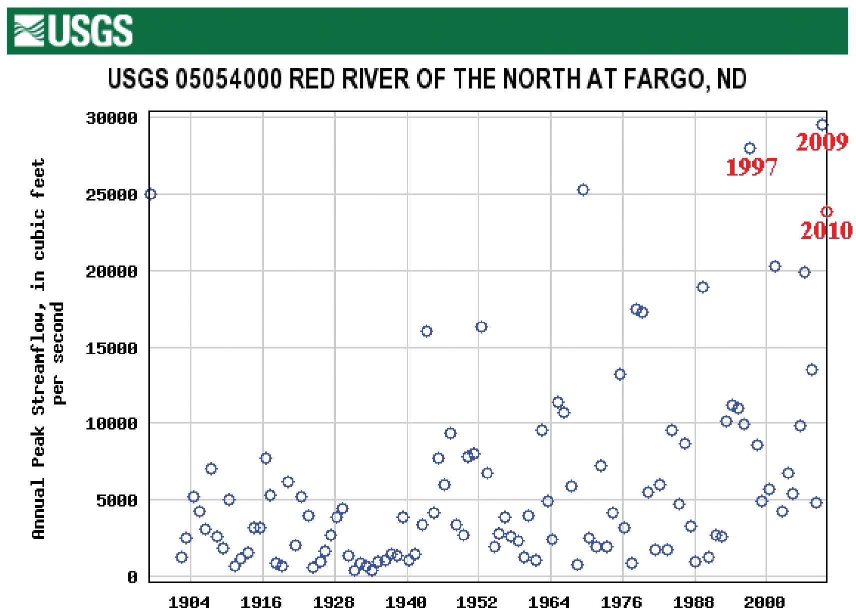


Agassiz Map - Teller, J. T., L. H. Thorleifson, L. A. Dredge, H. C. Hobbs and B. T. Schreiner. Maximum Extent and Major Features of Lake Agassiz [map]. 1:3,000,000. In: Geological Association of Canada. Special Paper 26. [Ottawa]: Geological Association of Canada, 1983

In terms of specificity of the Western Wild Rice Watershed, the acres of land above sustainable levels for soil erosion have demonstrated wide fluctuations in acreage from 1982 to 1997. One possible reason for this may be the excessive irrigation for potato production in this sub basin. The NRI, National Resources Inventory, estimates indicate 2,800 acres of the sub-basin agricultural lands still has water erosion rates above a sustainable level in 1997. NRI estimates show 30,400 acres of the sub-basin agricultural lands still has wind erosion rates above a sustainable level in 1997. Controlling erosion not only sustains the long-term productivity of the land, but also affects the amount of soil, pesticides, fertilizer, and other organic material that move into the basin's waters.

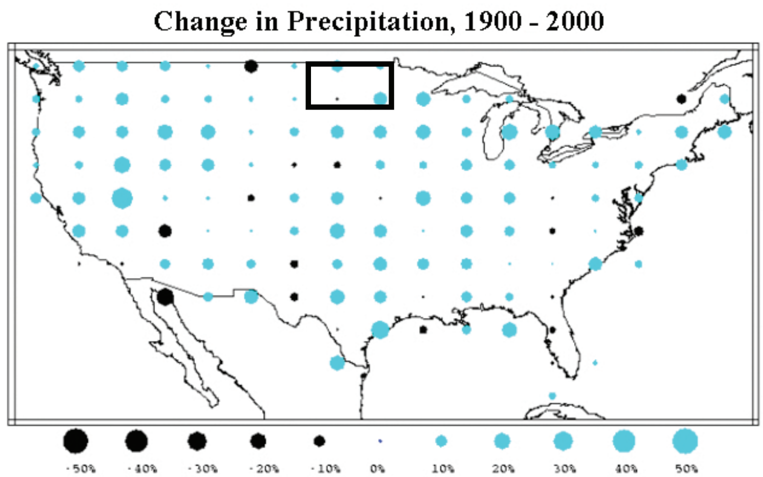
Through NRCS programs many farmers and ranchers have applied conservation practices to reduce the effects of erosion by water. As a result, water erosion rates on cultivated cropland were 1.0 tons/acre/year in 1997. Wind erosion rates were also 1.0 tons/acre/year. NRI estimates indicate 54,800 acres of Highly Erodible Land (HEL) in 1997 compared to 51,800 acres in 1987. This is nearly a 6% increase in HEL being farmed. Sixty nine percent of all listed stream, lake, and reservoir acres are listed for Total Fecal Coliform. Impairments from sediment and siltation were listed on 6 of the 13 identified Total Maximum Daily Load (TMDL) water bodies. Stream reaches listed for sediment are affected by erosion on croplands and from stream banks. Season-long grazing systems and lack of riparian buffers in cropland fields contribute to the stream bank erosion.
(U.S. Department of Agriculture, Natural Resources Conservation Service. 2003.)

Historically The USGS also cites five weather factors that historically act to enhance flooding along the Red River in years of documented extreme flooding. Firstly, above-normal amounts of precipitation in the fall of the year that produce high levels of soil moisture, particularly in flat surface areas, in the basin. North Dakota had its 22nd wettest fall in the 115-year record in 2009. Two, Freezing of saturated ground in late fall or early winter, before significant snowfall occurs, that produces a hard, deep frost that limits infiltration of runoff during snowmelt. As illistrated by the notorious 2009 flooding, Fargo had a November that was much warmer than average, followed by a sudden plunge to below-zero temperatures by the second week of December of 2008 and 2009. This froze the saturated ground to a great depth. Third, above-normal winter snowfall in the basin. North Dakota was in the top 15% winter for precipitation, with the period December 2009 - February 2010 ranking 15th wettest in the past 115 years. Fourth, above-normal precipitation during snowmelt. Precipitation for March 1 - 18 was been 1.41", compared to the average of 0.61". Fifth and lastly, above-normal temperatures during snowmelt. High temperatures in Fargo have averaged 6°F warmer than normal for March 1 - 18.



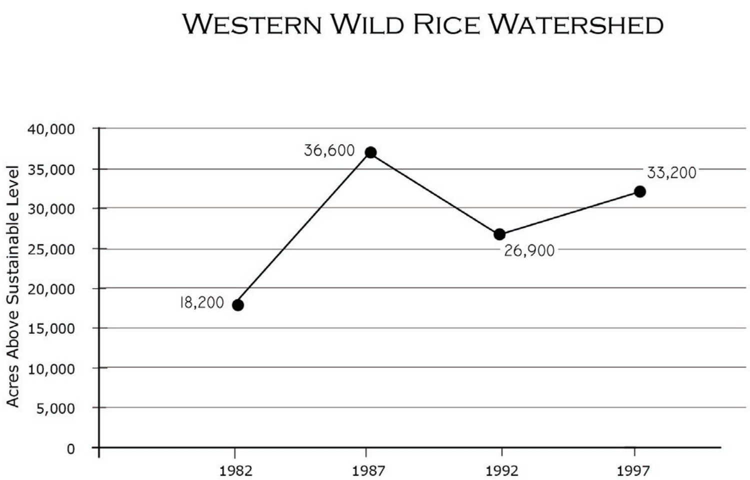
Damages from the l993 flood in the Midwest exceeded $18 billion. The flood inundated 10,300 square miles in nine states and 52 people lost their lives. There is uncertainty about whether these events qualified as 50 year, 100 year or 500 year events. In l993 only 52 lives were lost as a reflection of improved flood forecasting and warning systems. The Great Flood occurred between April and August and actually consisted of a series of floods. Within the immense storm systems were at least 175 cores of heavy rain, each producing more than 6 inches of rain in short periods and numerous flash floods (Changnon, 1996:6).

Reports show enormous regional impacts from the floods in terms of winners and losers (Groisman et al., 2002). At the national level, the floods did not significantly affect the national economy. From a broad financial perspective, government funds, insurance payments, and private capital have been spent to rebuild damaged property and the state's infrastructure, and these recovery expenditures represent a benefit to the state's economy. Are they losses or gains? Through popular media, the public tends to apply this term "mistake" to the geologic setting of cities elsewhere: a subsiding New Orleans, an earthquake-prone San Francisco, or a mudflow-prone Los Angeles. But many in the Red River Valley, while likewise smugly criticizing the geologic settings of cities elsewhere, either ignore or are oblivious to the hazards of their own setting. And this leads to a likewise smug expectation in the Valley that engineering can resolve what problems do occur. Thus, state taxpayers have funneled tens of millions of dollars into the Red River Valley, and subsequent Western Wild rice Watershed, for mitigation of damages – much of it wasted or expended unwisely on projects that often will only serve to increase the propensity for flooding or geologic failure. In addition, developers are often encouraged (or, at least, not discouraged) from building on those areas most prone to problems; when problems do occur, those involved with this development are among the first to call for mitigation and compensation.



Change in precipitation over the U.S. between 1900 - 2000, from the U.S. Cooperative network. Precipitation in the Red River drainage area increased by 10 - 20% over the 20th century. Image credit: Contemporary Changes of the Hydrological Cycle over the Contiguous United States: Trends (Groisman et al., 2002).

The anthropomorphic history of the area helps describe how land usage shifted in times of settlement and what it really means to own land in this part of the country. Pacification of the region's Indians, coupled with the completion of new railways, attracted 100,000 new settlers to Dakota Territory between 1879 and 1886. By 1890, North Dakota's population had reached 190,983. Bonanza farms, extensive operations exceeding 3,000 acres, helped popularize North Dakota's bounty. A series of harsh winters, floods, and drought later drove many pioneers away. A second wave of settlers from 1898 to 1915, mostly Scandinavians and Germans, increased the state's resident population to 646,872 by 1920. (Encyclopedia Britanica 2010)



The acres of land above sustainable levels for soil erosion have demonstrated wide fluctuations in acreage from 1982 to 1997. One possible reason for this may be extensive irrigation for potato production in this sub-basin. (USDA-NRCS, NRI data.)

However a twenty-year depression, compounded by prolonged drought, began in 1921. Hardship and out-migration followed as 40,000 residents fled the state, dubbed "the Too Much Mistake, " during the 1930s. Favorable weather conditions and wartime demand for commodities triggered an economic recovery. By 1974 increased global demands produced record-breaking commodity prices. Within two years, however, slumping grain sales and plummeting wheat prices drove many farmers into bankruptcy. Agricultural price supports became a necessary means of survival for many farmers. (North Dakota, 2010) During the 1990s, weak international demand for American commodities produced even lower prices. The Federal Agricultural Improvement and Reform Act of 1996, which replaced price supports with a fixed and slowly declining subsidy, aggravated the situation. Not surprisingly, the decline of the state's family farms continued.

While North Dakota's reliance on agriculture declined, the state remained a major producer of wheat, sugar beets, barley, sunflower seeds, canola, and flaxseed. The success of producer-owned cooperatives, particularly the Minn-Dak Farmers Cooperative and the Dakota Pasta Growers Association, became encouraging. In addition, the growth of the state's food processing and agricultural equipment manufacturing industries helped revive North Dakota's slumping agricultural economy (ND Historical Society). With the push for environmentalism becoming a larger topic in struggling economies many land owners are looking for government subsides or tax cuts in exchange for environmental awayness and biologically friendly practice in their usual routine.

Despite the seemingly sudden assaults of the Red River and its tributaries, this struggle between water and man has been going on for decades. As such there are large amounts of data concerning flood levels, storm water run-off, 100 year storm levels, and watershed characteristics along with the hundreds of levels, all of which can be integrated with land use layers, ecological zones, plant communities etc. All data is globally positioned and verified accurate, with content that spans entire continents and seasons from years logged for as long as the NRCS or Army core of engineers has been keeping track. Roger Tomlinson is the Ottawa scientist who invented GIS in the 1960's. Technically speaking it remains a geographic information system (GIS); its technology that integrates computer hardware and software to translate geospatial information into topographic, demographic, utility, facility, image and other resource data that is geographically referenced. GIS is used to improve the efficiency of and simplify public services, city planning, emergency operations and travel logistics. Applications are as wide as the human imagination. Geographic information about physical landmarks in many forms is continuously distributed across departments at all government levels, in special jurisdictions and in all utilities. The range of information varies from demographics and traffic patterns to school locations and floodwater landmarks.

In this modern world GIS technologies have become the tool of globally accurate and digitally connected resource manager, who can share and discuss environmental conditions and theories with others in similar fields instantly. This will be the main vehicle for my site analysis to ensure my research is still progressive and not redundant with existing information. Along with the increased political and environmental focus on the infamous flooding in the Red River Valley, there is far to much specific data that has been brought forth to efficiently recorded every facet that adds to the destructive floods that still return every year. To navigate this I will look at multidimensional mapping date like ecological zones that inherit have constituents associated with them on any scale.

Design approach

Upon first impression, the area areas of North and South Dakota that the Western Wild Rice Watershed covers is much like any rural expanses located in America's bread basket. Because most farms in the area are full time operations, and usually sized over 1000 acres; agriculture has a very dominant presence here, especially when weighted against the lack of human built structures. The crop fields in this part of the world seem to go on forever but unlike areas in this country like Kansas of Iowa, there is a large respect for land that is not being used. Fields are always broken up by small rural roads but much of the watershed's non-crop diversity comes with regard to main drainage ways and lowland water storage areas. Small 1960's farmstead are seen as the common dwelling, dotting the vast flat expanses that was once tall grass prairie and previously enormous continental lake. Inhabitants in this modern era can now cultivate whatever will economically benefit them the most based on agricultural markets, economic climate or even global climate; here you see the repetition of corn, soybean, sunflower, wheat, and CRP or Conservation Reserve Program lands. What was once a great sea of wavering grass is now stretches of monoculture plots on an entire regional scale; where there was oak savannas and complex biodiversity now sits roundup ready corn hybrids and genetically modified plants; where once roamed great herds of American bison now is home the mile upon mile of fenced, domesticated cattle.

Yet the dominant season that truly exemplifies the mentality in the local culture, is winter. For the majority of the year this area is a seemingly barren waste of snow and ice blanketed in a bitter shell of endless white. Some of the worst winter conditions in the country give this place the notoriety and respect it deserves. Winter winds peak and most of the trees shed their foliage aside from the few coniferous imports that shield tree lines windbreaks and lone dwellings. Wildlife in the area either flies to the south or collectively holds its breath as all remaining processes submit to the North Dakota winter.

Still every year winter loosens its icy grip on the world and the desert of white is transformed into a rich basin full of new life and an almost tangible feeling of rebirth. Unfortunately this also heralds the annual coming of the floods. Fields drain, channels fill, and rivers rise to swallow the flatlands along the Red River's banks. So many current systems and landscapes help to fuel the inundation of the area ranging from plant communities, water retention, and soil types to land development, agricultural practices and increased runoff. Its no question that many variables in this area's ecological resilience have been compromised leading to assessments of which landscapes are foundering and to what extent are they degraded.

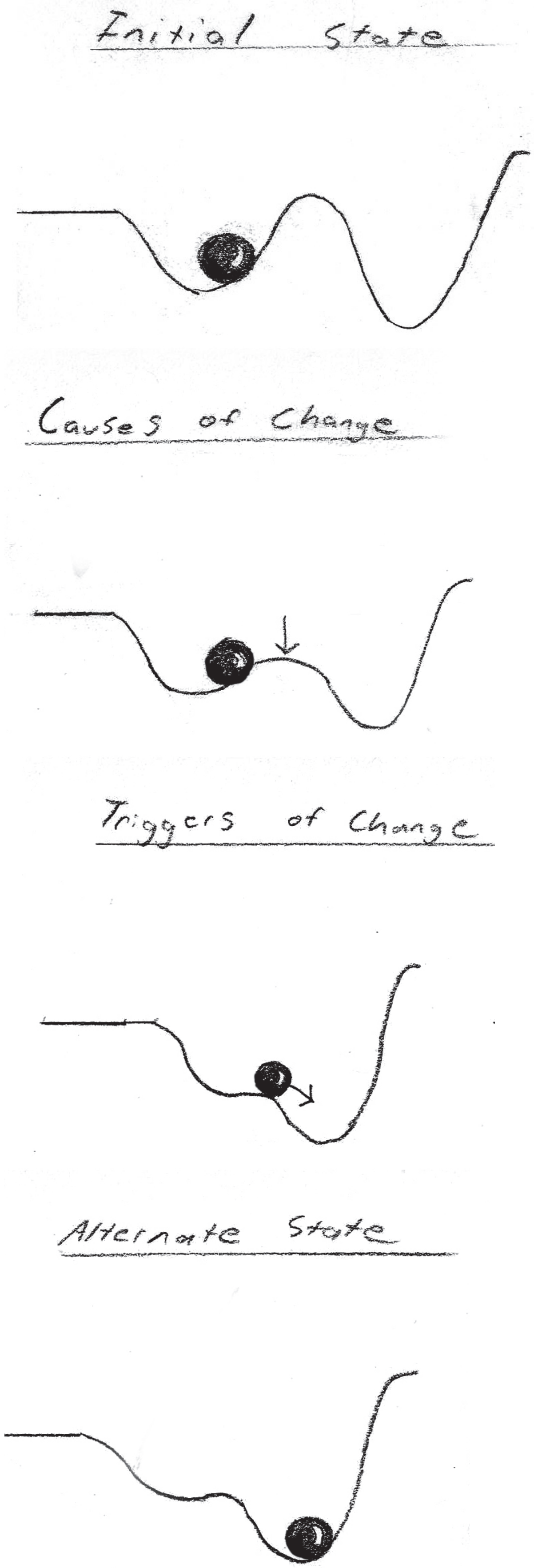
As bleak and terrible as this introduction to a site can be, it comes from the eyes of someone who grew up in the out-of-doors and has spent many years fighting the elements as a rural farmer and resource management employee for a number of refuges and parks in Minnesota. What we all take for granted is the true unique beauty that this areas has, that is unlike anywhere else in the world. Early settlers and explorers described the northern tall grass prairie as a sea of grass, undulating waves splashed with colors from a wide variety of wildflowers. Shimmering ponds were scattered throughout the grassy sea. Trees were absent from the landscape, except along rivers and creeks. Large herds of bison roamed these vast grasslands, often followed by wolves that fed on weak and sick animals. Ducks, geese, and shorebirds darkened the sky during migration. Sharp-tailed grouse danced during courtship, small brown sparrows darted in and out of the tall grass after insects, and hawks floated on wind currents eying the thick grass below for a tasty mouse or rabbit meal.

Refuge wetlands, prairies, grasslands, and stream corridors provide wildlife with diverse habitats that meet their needs. East meets west in this part of the country both geologically and biologically; birds commonly associated with eastern woodlands and birds common in Midwestern grasslands are found here; during the course of a year, over 243 different bird species use endemic habitats to the Prairie Pothole Region of North Dakota. Wetlands throughout the watershed come in a variety of sizes and depths. Temporary and seasonal wetlands fill with water in the early spring from snowmelt and are usually dry by mid-summer. These smaller wetlands provide important food resources for migrating birds and pair habitat for breeding ducks. Larger, more permanent wetlands usually hold water year-round unless drought conditions exist. Waterfowl, wading birds, marsh wrens, muskrats, mink, leopard frogs, and painted turtles are a few of the species that depend on local wetlands.

Remnants of the once vast tall grass prairie are still found on hillsides, around wetlands, and in small scattered tracts all accords the Red River valley sub-basin. A wide variety of tall grasses, including porcupine grass, big bluestem, Indian grass, switchgrass, and cordgrass, are common. Purple coneflower, Maximillian sunflower, prairie lily, blazing stars, and ladies tresses are just a few of the colorful wildflowers found in these beautyful prairies. Several species of prairie birds, including the upland sandpiper, bobolink, short-eared owl, and northern harrier, use the native prairies. Butterfly species, including monarchs, regal fritillarys, and skippers, are found only on the native prairie sites.

As exemplified in a contextually relevant case study, economic feasibility can be evaluated through benefit-cost ratios calculated for a future 20- year period. Costs included land rentals, and restoration and construction costs, which varied by type of restoration and as a function of wetland size. Benefits (reduced flood damage) for a hypothetical 20-year future period should be based on historical flood damage (1989 to 1998) both within and downstream of the watersheds along with hydrologic modeling estimates of reductions in peak flood stage with alternative storage scenarios and flood events in the Western Wild Rice Watershed (Steven D. Shultz 1999).

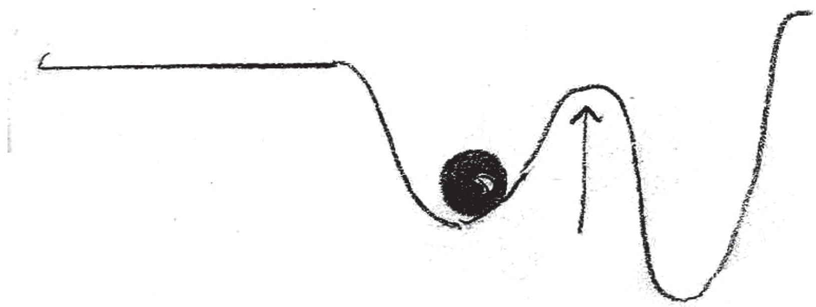
Alternate Stable States and Regime Shift



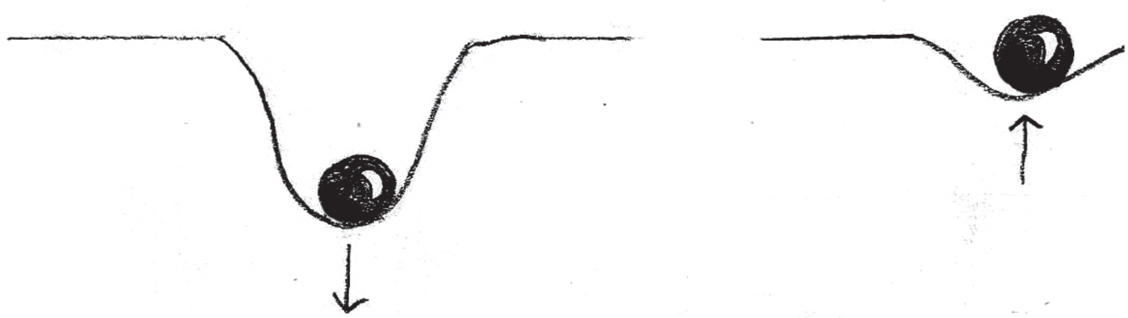
In ecology, the theory of alternative stable states sat that ecosystems can exist under multiple “states” or sets of unique biotic and abiotic conditions. Ecosystems can change and transition from one stable state to another, in what is known as a state shift; sometimes termed a phase shift or regime shift. Due to ecological feedbacks and natural system’s ability to adapt and change, ecosystems display resistance to state shifts and therefore tend to remain in a given state unless disturbances or certain modifying variables are large enough. Multiple states can persist under equal environmental conditions, a phenomenon known as hysteresis. Alternative stable state theory suggests that discrete states are separated by ecological thresholds, in contrast to ecosystems which change smoothly and continuously along an environmental gradient

Alternate stable states are most commonly described through a visual model of a “Ball-in-Cup” system. The ball represents a given ecosystem, and it sits on a plain where any point along the surface can be seen as a possible state. In the simplest model the plain has two valleys that are separated by a hill. When the ball is in a valley, or in a “domain of attraction,” it exists in a stable state and must be perturbed or dramatically disturbed to move from this state. In the absence of these changing variables, the ball will always roll downhill and therefore will tend to stay in the valley, or its stable state.

Resiliance against regime shifts



Ecosystems are inherently resistant to state shifts – they will only undergo shifts under substantial perturbations – but some states are more resilient than others. In the ball-and-cup model, a valley with steep sides has greater resilience than a shallow valley, since it would take more force to push the ball up the hill and out of the valley.



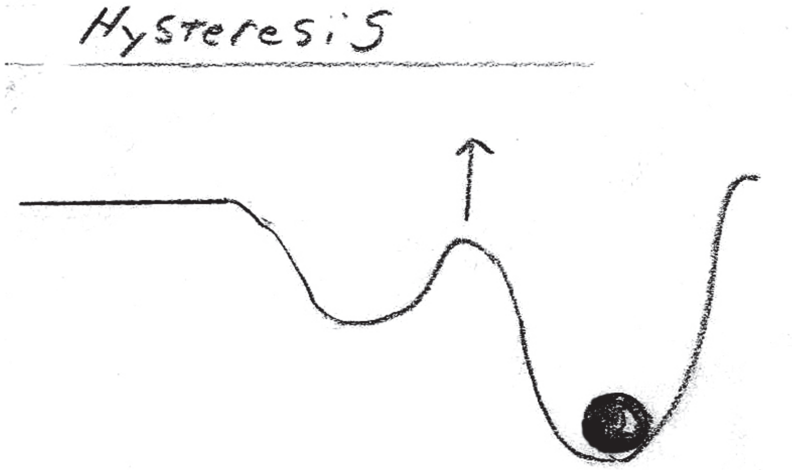
Often, humans influence stable states by reducing the resilience of basins of attraction. Here are at least three ways in which anthropogenic forces reduce resilience:

- Decreasing biological diversity and functional groups, often by top-down effects (e.g., overfishing, overhunting of predator species [W. Ripple R. Beschta});

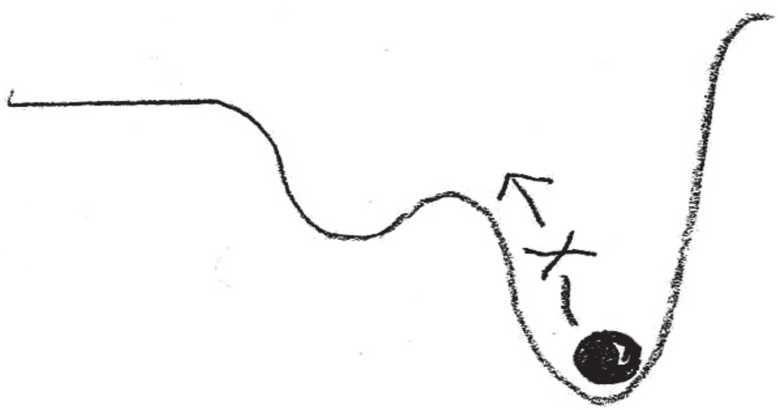
- Altering the physico-chemical environment (e.g., climate change, pollution, fertilization runoff)

- Modifying existing disturbance regimes to which organisms are adapted (e.g., bottom trawling, coral mining, or creating drastic seasonal flooding.).

Resiliance against regime shifts

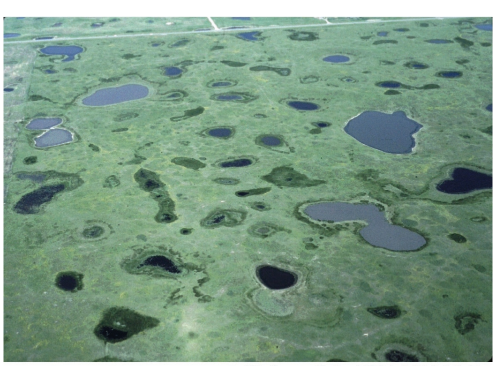


The idea of Hysteresis can happen from changes to variables or parameters. When variables are changed, the ball is pushed from one domain of attraction to another, yet the same push from the other direction cannot return the ball to the original domain of attraction. When parameters are changed a modification to the landscape results in a state shift, but reversing the modification does not result in a reciprocal shift to return to a past state.

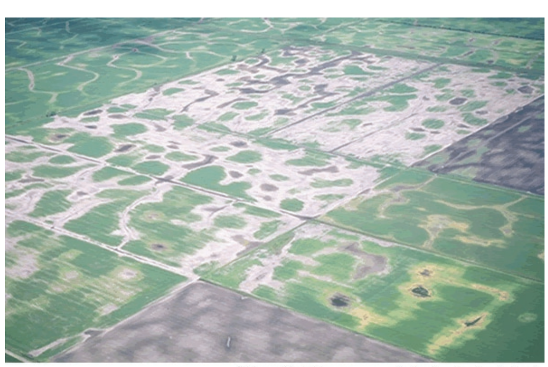


When an ecosystem's resilience is decreased, its controlling systems can be pushed into alternative, and often less-desirable, stable states with only minor perturbations. When hysteresis effects are present, the return to a more-desirable state is sometimes impossible or impractical. Shifts to less-desirable states often entail a loss of ecosystem service and function, and have been documented in an array of terrestrial, marine, and freshwater environments, and spcifically the watersheds in the great plains.

The design of this management plan looks to ensure the continued existences of pivotal variables that sustain natural life in this area. If these crucial systems can be fostered for continued sustainability and resilience, other corresponding process can more easily adapt themselves to the shifting regime as others have. If hysteresis can be avoided many natural systems can acclimate to changing contextual influences and find a new niche of existence with an emerging new world order.



**http://commons.wikimedia.org/wiki/File:Prairie_Pothole_Wetlands.jpg



** http://mrbdc.wrc.mnsu.edu/org/bnc/wetlands.html

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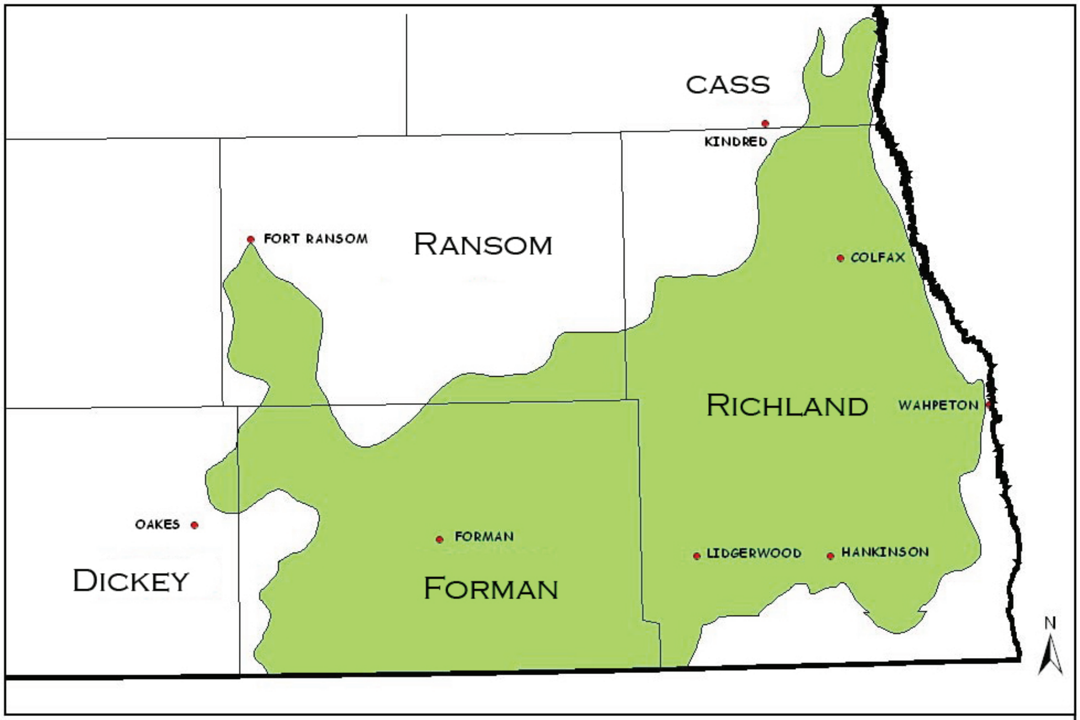


Western Wild Rice watershed
IIUC - 09020105

The Western Wild Rice Watershed:

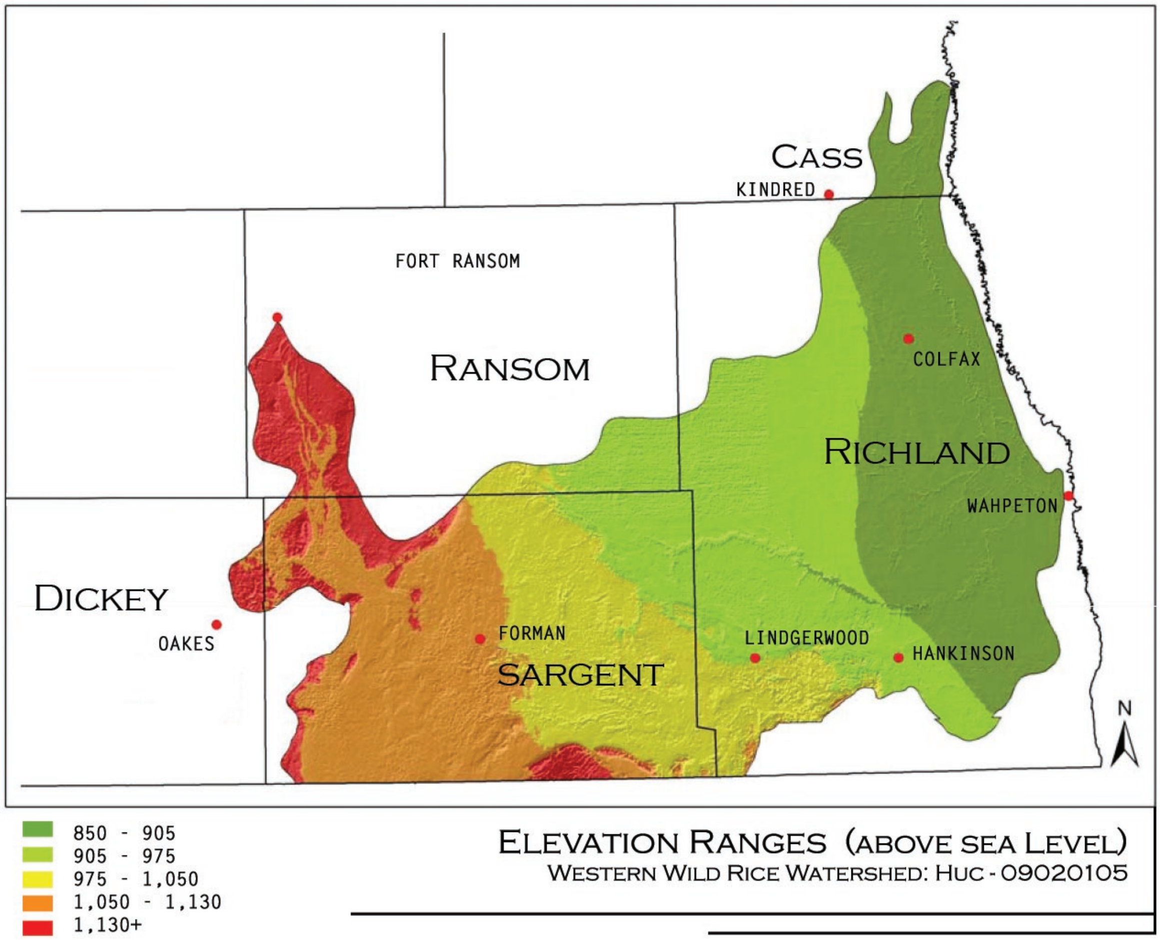
**8-Digit Hydrologic Unit Code (HUC) (09020105)*

This sub-basin includes land in North Dakota and South Dakota. There are approximately 1,475,000 acres in the entire sub-basin. This sub-basin is located in Souris-Red-Rainy River Region, Red River Sub-Region. This thesis addresses only the portion located within North Dakota.

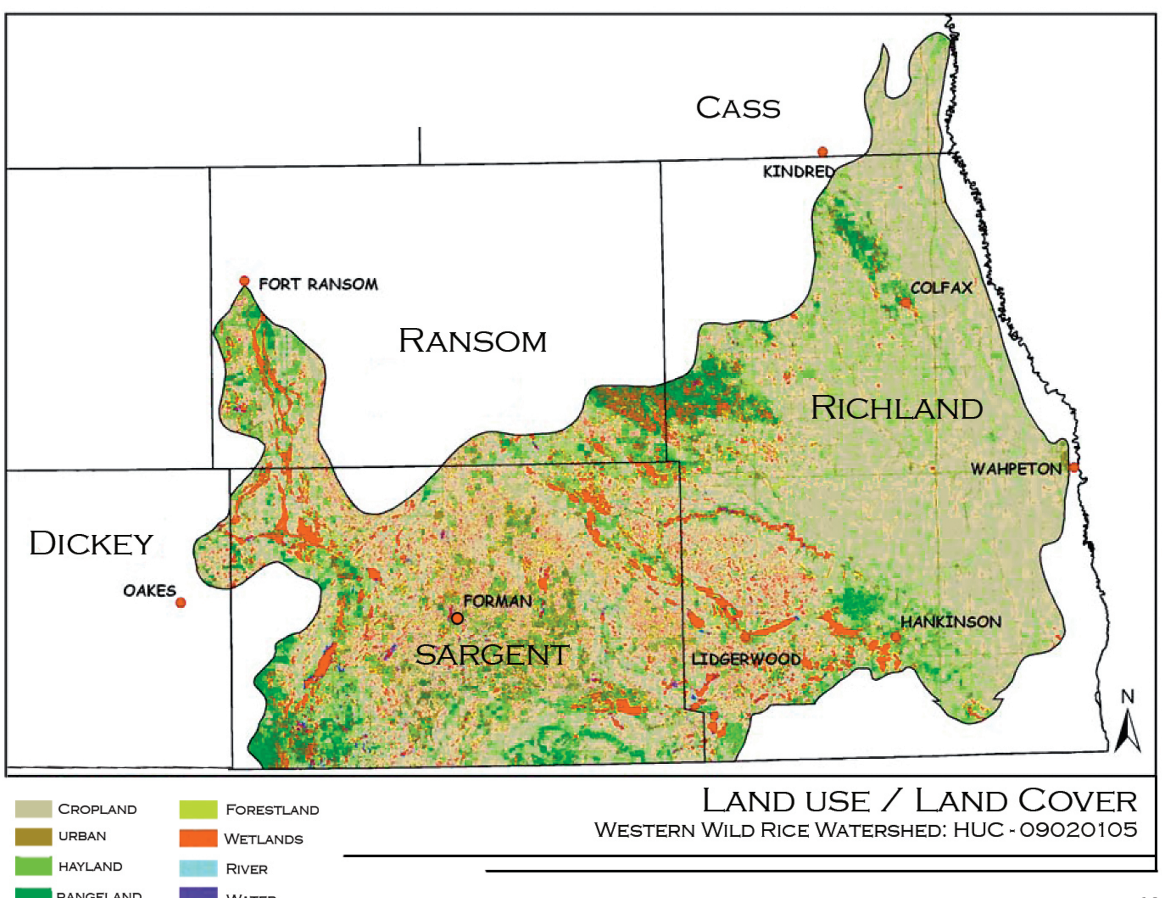
The Western Wild Rice is approximately 1,301,000 acres covering parts of five counties (Cass, Dickey, Ransom, Richland, and Sargent) in North Dakota. Of the 1,301,000 acres, Dickey County contains 1%, Cass 3%, Ransom 6%, Richland 51%, and Sargent 39%. There are approximately 1,128 farms in the sub-basin. The following maps show the entire sub-basin and also the portion of the sub-basin located within North Dakota.

This sub-basin encompasses commodities ranging from sugar beets, corn, soybeans, and multiple small grain crops to beef and dairy cattle, swine, and turkeys.

Conservation has current active assistance provided by five Natural Resources Conservation Service (NRCS) service centers, one soil survey office, and two Resource Conservation & Development Councils.



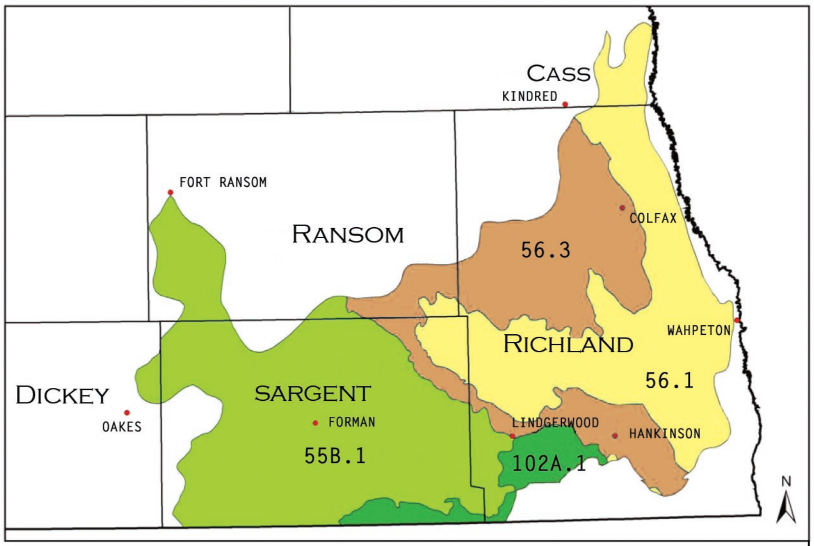
Elevation Ranges (above sea Level)
Western Wild Rice Watershed: HUC - 09020105



Land use / Land Cover
Western Wild Rice Watershed: HUC - 09020105

Physical Description

Common Resource Areas (CRA) are simply put, geographical areas where resource concerns, problems, or treatments are similar. Landscape conditions, soil, climate, human considerations, and other natural resource information are used to determine the geographic boundaries. CRA's are subsets of Major Land Resource Areas. The following map shows the CRA's for Western Wild Rice sub-basin with the CRA descriptions below.



Common Resource Areas (CRA)
Western Wild Rice Watershed: HUC - 09020105

Land Cover/ Land Use	Acres	Percent of HUC
Cropland	972,700	75
Rangeland	100,800	8%
Conservation Reserve Program (CRP) Land [2a]	62,100	5%
Pastureland	56,300	4%
Urban/Farmstead/ Transportation Land	41,900	3%
Federal Lands	25,300	2%
Tame Grass/Hayland	23,700	2%
Water/Wetlands	10,700	1%*
Forestland	1,400	1%*
Other Lands**	6,100	1%*
North Dakota HUC Totals [b]	1,301,000	100%*

** Less than one percent of total acres. See below for special considerations.*
*** Other land includes farmsteads, windbreaks, marshland, etc.*
a: Estimate from Farm Service Agency records and include CRP/CREP.
b: Totals may not add due to rounding and small unknown acreages.

Irrigated Land		
	8,560	<1%

+ *Land Cover / Land Use (National Resources Inventory [NRI]*
+ *Irrigated Land (Farm Security Agency)*

55B.1 – Central Black Glaciated Drift Plain:

The Central Black Glaciated Drift Plains are a gently rolling to undulating landscape with a thick layer of glacial till. Temporary and seasonal wetlands are numerous throughout the area. These soils are very fertile, but agricultural success is subject to annual climatic fluctuations. Most of the soils are deep,well drained and moderately well drained, sandy to clayey, and have a frigid temperature regime.(Farm Services Agency (FSA)).

56.1 – Red River Valley:

The Red River Valley (Glaciated Lake Agassiz) is an extremely flat landscape composed of thick lacustrine sediments. Soils range from silty to clayey in texture. Most soils have a high water table and are very productive. Saline soils exist in places. Most areas are farmed with main crops being small grain, sugar beets, and soybeans. The native vegetation was tall grass prairie. Primary resource concerns are soerosion and deposition by wind. (FSA)

56.3 - Sheyenne Delta of the Red River Valley:

The Sheyenne Delta landscape ranges from strongly rolling sand dunes in the northeastern edge, to nearly level high water table sandy soils of the south. A risk of wind erosion exists throughout this area. The area is used for range and cropland. A portion of the Sheyenne delta is in the Sheyenne National Grassland. (FSA)

102A.1 - Rolling Till Prairie:

Gently sloping to steep, loamy glacial till soils with scattered sandy outwash soils and silty alluvial flood plains soils. This area is part of the Prairie Pothole Region of the upper Midwest. Predominantly cropped to corn and soybeans with increasing hayland and pasture and small grains in the western part. Resource concerns are water and wind erosion, nutrient management, and water quality. (FSA)

Soil Productivity

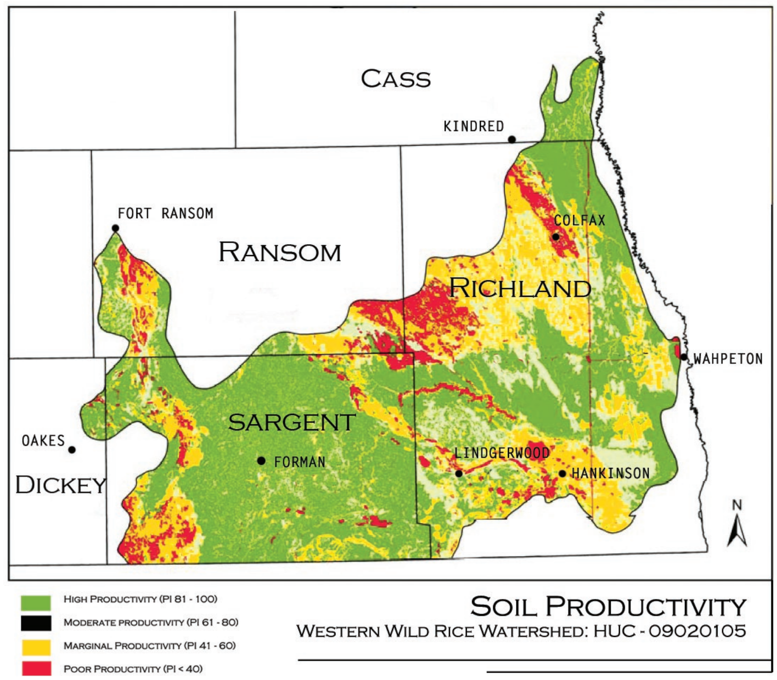
The Western Wild Rice sub-basin has a wide variety of soil productivity. The Sheyenne Delta has coarser soils with productivity indexes ranging from moderate to poor. The fine textured lake sediments of Glacial Lake Agassiz and adjacent glacial till plain have moderate to high productivity.

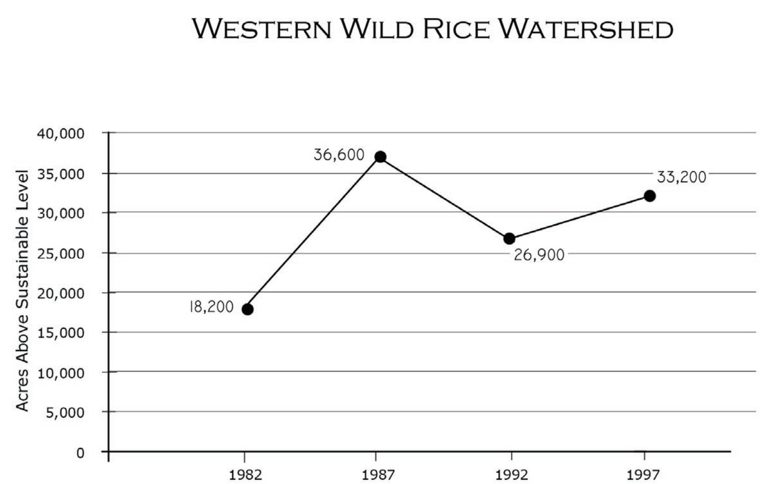
- NRI estimates show this sub-basin has 30,400 acres of agricultural land with wind erosion and 2,800 acres with water erosion rates all above a sustainable level in 1997.

- Controlling erosion not only sustains the long-term productivity of the land, but also affects the amount of soil, pesticides, fertilizer, and other organic material that move into the basin's waters.

- Through NRCS programs many farmers and ranchers have applied conservation practices to reduce the effects of erosion by water. As a result, water erosion rates on cultivated cropland were 1.0 tons/acre/year in 1997. Wind erosion rates were also 1.0 tons/acre/year.

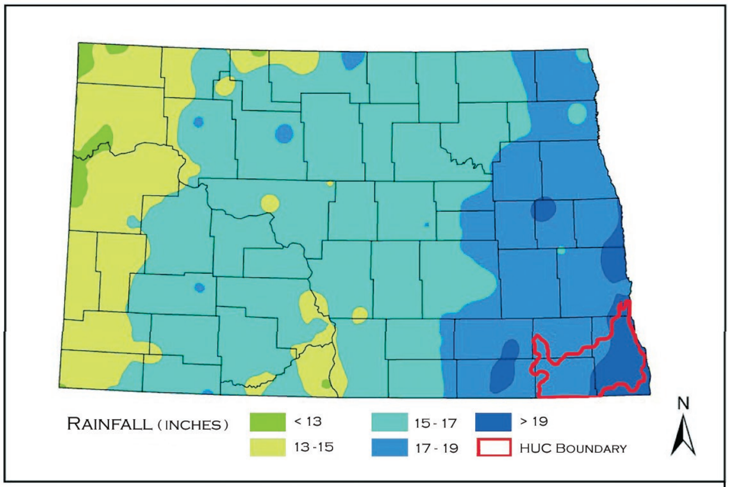
- NRI estimates indicate 54,800 acres of Highly Erodible Land (HEL) in 1997 compared to 51,800 acres in 1987. This is nearly a 6% increase in HEL being farmed.





The acres of land above sustainable levels for soil erosion have demonstrated wide fluctuations in acreage from 1982 to 1997. One possible reason for this may be extensive irrigation for potato production in this sub-basin. (USDA-NRCS, Natural Resource Inventory NRI data.)

Hydrological Productivity

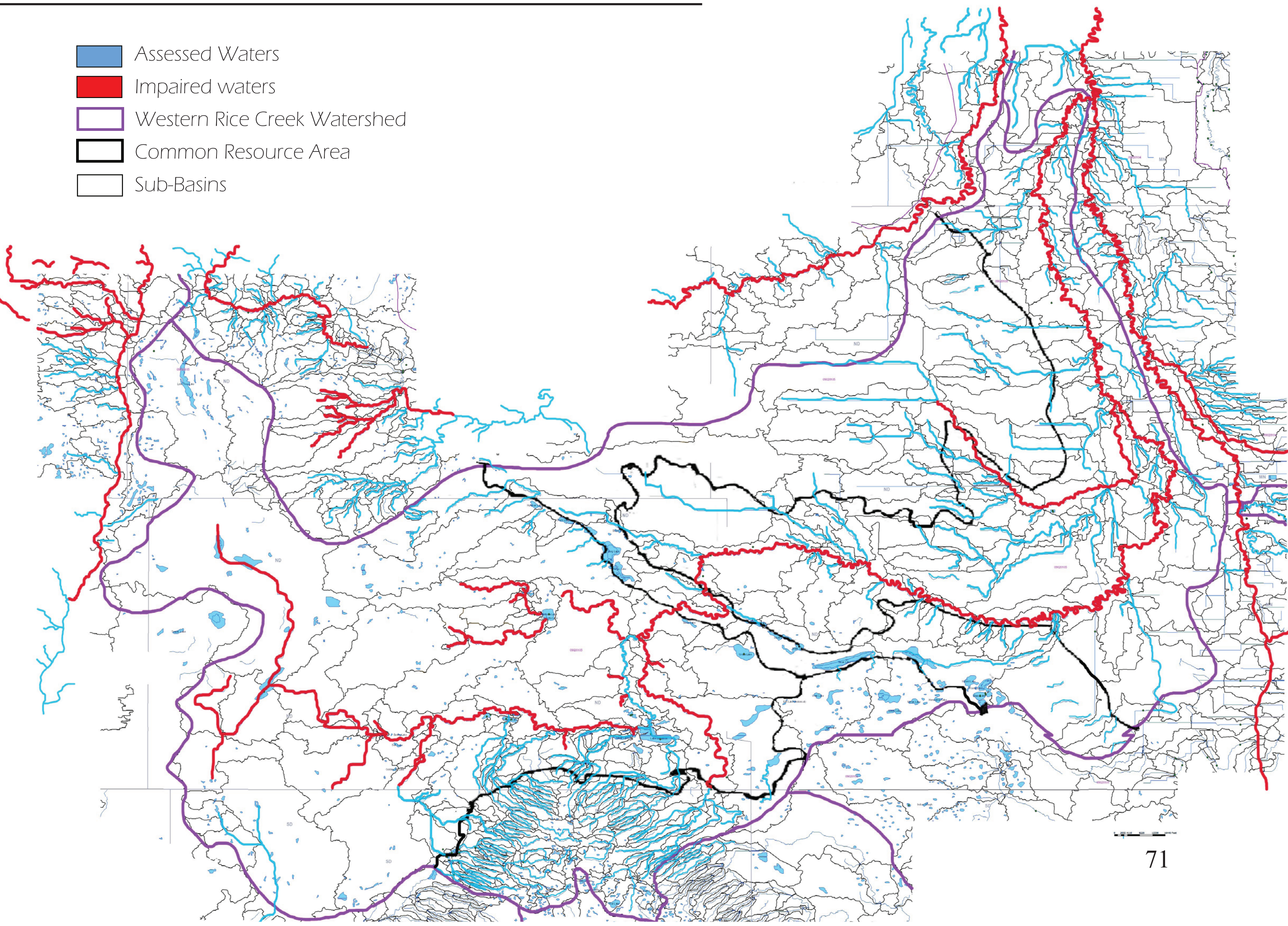


Average Annual Precipitation
Western Wild Rice Watershed: HUC - 09020105

69% of all waters listed as streams, lakes, and reservoir acres are impaired due to total fecal coliform, which means run off from cow manure. Impairments from sediment and siltation were listed on 6 of the 13 identified Total Maximum Daily Load (TMDL) water bodies. Stream reaches listed for sediment are affected by erosion on croplands and from stream banks. Season-long grazing systems and lack of riparian buffers in cropland fields contribute to the stream bank erosion.

Conservation practices that can be used to address these water quality issues include erosion control, nutrient and pest management, grazing management, agricultural waste management/utilization, and riparian buffers

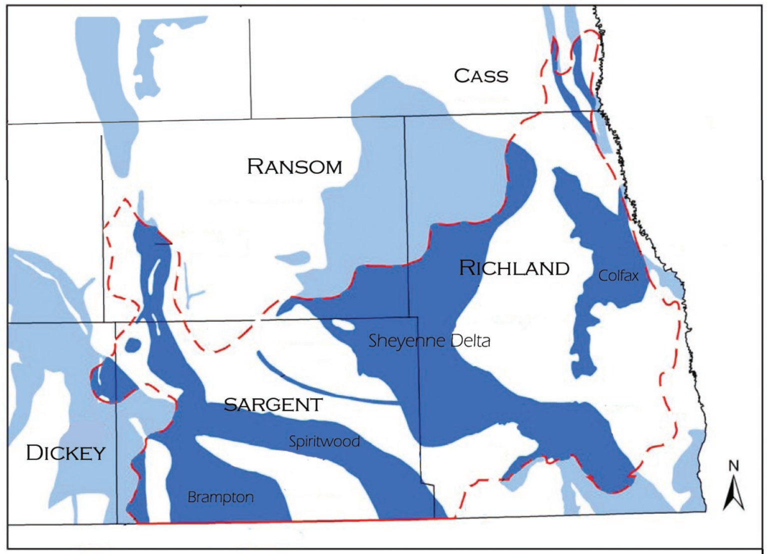
Western Wild Rice watershed



Water Quality

Aquifers:

There are eleven glacial drift aquifers located below the Western Wild Rice Waytershed Sub-basin. Nine of them are identified as "shallow" aquifers. (Englevale, Oakes, Brampton, Milnor Channel, Brightwood,. Hankinson, Colfax, Sheyenne Delta, and West Fargo). Two are identified as "deep". (Spiritwood and Gwinner). These aquifers are the source of water for multiple municipal and rural water users associated in Southeastern North Dakota.



Aquifer Location
Western Wild Rice Watershed: Huc - 09020105

Wellhead Protection Areas:

As of January 2003, there were 13 protection areas located in the sub-basin. They are designated to protect municipal water. Conservation practices that can be used to address these water quality issues include grazing management, erosion control, nutrient and agricultural waste management, along with riparian buffers.

- Total fecal coliform, sediment and nutrients are primary water quality pollutants impairing the watershed streams and lakes.
- The Wild Rice River has a large number of livestock operations on or near the river, impacting water quality from nutrient loading and total fecal coliform.
- There are three shallow aquifers that are considered sensitive to nitrate and pesticide loading.
- Lack of adequate riparian buffer width and health are impacting water quality and stream health.
- Flooding is a major concern that impacts crop production, and wetland draining or filling.
- Season long grazing near riparian or shoreline zones is contributing to fecal coliform in the water
- Water conservation and water quality (potential for pesticide and nutrient contamination) are is
- Urban related runoff/storm water entering into the water causes a concern for nitrates.

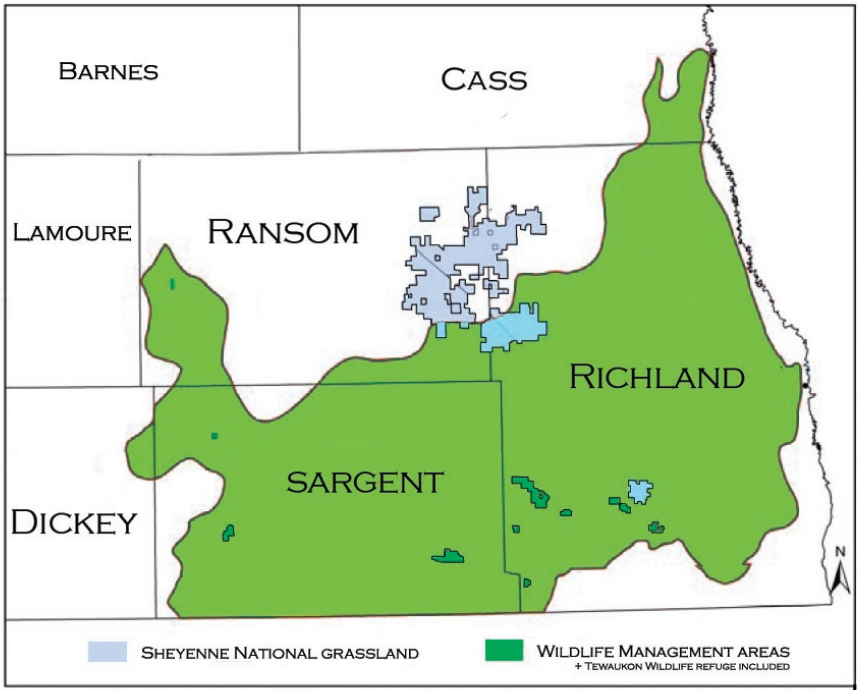
		Units	North Dakota	Western Wild Rice Sub-basin	Western Wild Rice as percent of Noth Dakota	Impared Water Quality	Percent Impared Western Wild Rice
Water Quality Data * percent of total miles and Acers in watershed	Total - Major Water Bodies						
	Rivers / Streams	Miles	56,687	880	1.6%	459	52%
	Lakes / Reservoirs	Acres	434,658	3,700	0.9%	298	8%

Vegetative quality

- Major concerns for localized vegitation include are controlling invasive weeds and maintaining good pasture conditions.
- Direct seeding of corn and soybeans has been successful in some locations.
- Noxious weeds and poor range condition reduce productivity for livestock and wildlife.
- The private, non-industrial forestland is associated with small woodlots or rural home sites which are not actively managed for timber production.
- Western Prairie Fringed Orchid is listed as a Threatened Species (see table in Animals section below)

Federally Listed Threatened and Endangered Species			
Species Category	Threatened	Endangered	Candidate
Mammals	None	Gray Wolf	None
Birds	Bald Eagle	Whooping Crane	None
Fish	None	None	None
Invertebrates	None	None	Dakota Skipper
Plants	Western Prairie Fringed Orchid	None	None
Critical Habitat - None			

Animal Quality



Wildlife Management Areas w/ National Grasslands
Western Wild Rice Watershed: HUC - 09020105

ND Game and Fish has just over 5,800 acres of Wildlife Management Areas (see adjacent map) which are open to hunting and fishing.

Part of the Sheyenne National Grasslands (US Forest Service) is located within the HUC.

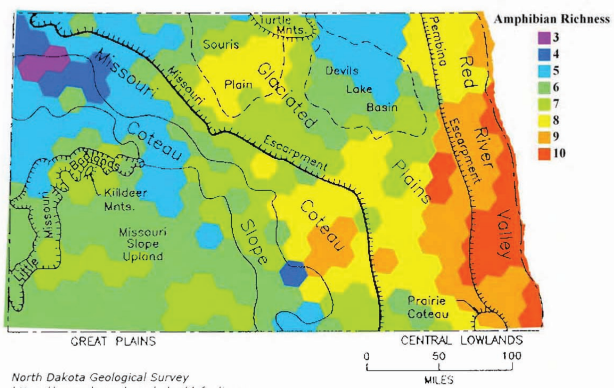
US Fish and Wildlife Service's Tewaukon National Wildlife Refuge (8,363 acres) is located in the HUC.

Animals that are threatened and endangered can be seen in the above table of threated and endangered species.

Species richness Analysis

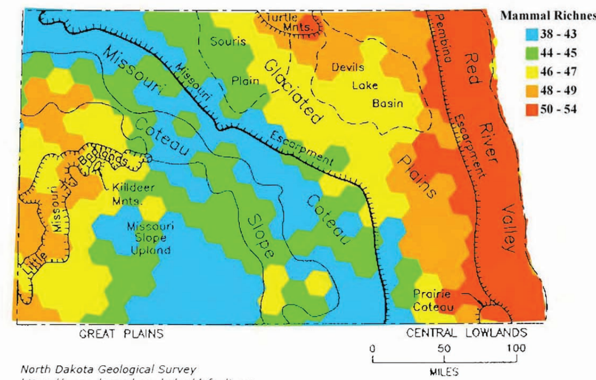
This location- independent indicator of species richness is useful in identifying habitats with a large number of species but also is sensitive to the resolution or scale of the land cover legend.

Calculation of species richness in each of the eight general land cover categories and the 39 finer-scale land cover categories reveal the scale dependence of species richness calculations.



North Dakota Geological Survey
https://www.dmr.nd.gov/ndgs/default.asp

Land cover category	Bird species richness	Mammal species richness	Reptile species richness	Amphibian species richness
Cropland	37	22	2	1
Planted Herbaceous Perennials	62	32	3	4
Wet-Mesic Tallgrass Prairie	38	29	5	5
Mesic Tallgrass Prairie	37	33	3	4
Mesic Tall and Mixed grass Prairie	63	33	4	5
Bluestem-Needlegrass-Wheatgrass Prairie	31	26	3	3
Wheatgrass Prairie	61	39	7	5
Needlegrass Prairie	60	43	6	4
Little Bluestem Prairie	56	44	8	4
Fescue Prairie	52	25	4	4
Sand Prairie	50	30	8	3
Saline Prairie	39	16	6	9
Upland Deciduous Shrubland	62	34	6	3
Lowland Deciduous Shrubland	59	27	6	9
Sagebrush Shrubland	30	29	4	0
Ponderosa Pine Woodland	50	41	4	0
Limber Pine Woodland	49	33	5	0
Rocky Mountain Juniper Woodland	49	27	6	1
Mixed Conifer and Deciduous Woodland	89	35	6	4
Floodplain Woodland	101	37	6	7
Deciduous Woodland	76	36	6	2
Green Ash Woodland	84	43	6	2
Aspen Woodland	79	43	6	1
Bur Oak Woodland	77	41	6	2
Aspen-Bur Oak Woodland	79	43	6	2
Lacustrine Wetland	60	10	5	10
Riverine Wetland	53	8	4	10
Palustrine Temporary Wetland	35	18	6	10
Palustrine Seasonal Wetland	50	16	6	9
Palustrine Semi-permanent Wetland	59	14	7	9
Sparse Vegetation - Others	26	27	9	4
Sparse Vegetation - Badlands	26	27	9	4
Sparse Vegetation - Riverine	2	0	0	4
High Density Residential and Commercial	17	3	0	1
Low Density Residential and Recreation	59	22	2	1



North Dakota Geological Survey
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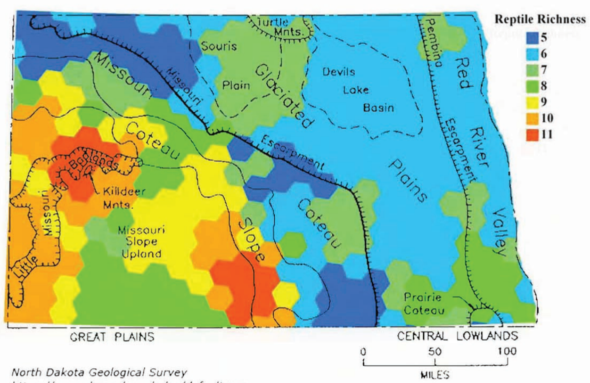
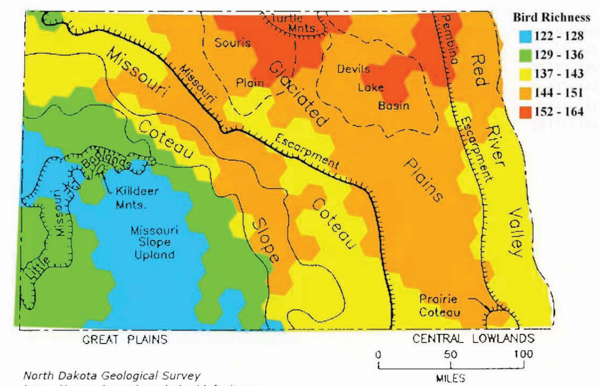


North Dakota Geological Survey
https://www.dmr.nd.gov/ndgs/default.asp

Vertebrate species richness by eight general land cover categories.

Land cover category	Bird species richness	Mammal species richness	Reptile species richness	Amphibian species richness
Woodland	134	57	8	7
Prairie	82	50	11	10
Shrubland	87	47	9	9
Planted Herbaceous Perennials	62	32	3	4
Sparse Vegetation	27	27	9	4
Cropland	37	22	2	1
Wetland	76	22	9	11
Urban	59	22	2	1



North Dakota Geological Survey
https://www.dmr.nd.gov/ndgs/default.asp

For example:

At the level of eight general land cover categories, mammal and bird species richness calculations are greatest for the wood land category.

- However, Little Bluestem Prairie and Needlegrass Prairie have mammal species richness comparable to or exceeding that of some woodland habitats when species richness is calculated using the more detailed land cover classification system.

For birds, the Floodplain Woodland category had the highest species richness, and deciduous woodland categories had species richness greater than prairies and wetlands which presumably reflects the greater number of niches provided by the vertical structure of woodlands despite their small spatial extent in North Dakota.

Social / economic Quality

Here is a social economic analysis of the populace within the Western wild rice Watershed to gauge level of willingness and ability to participate in conservation.

Three percent of the operators are minority produces in both ethnicity and crop. Limited resource farmers are estimated at just over three percent. This point to the potential need for special technical assistance targeted to reach people who:

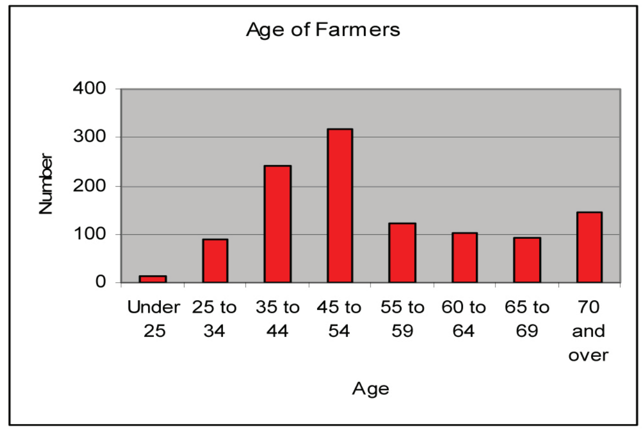
1) May lack experience with government farm programs
2) have good stewardship intentions but lack management skills
3) Lack the time to assist an NRCS field office and seek assistance.

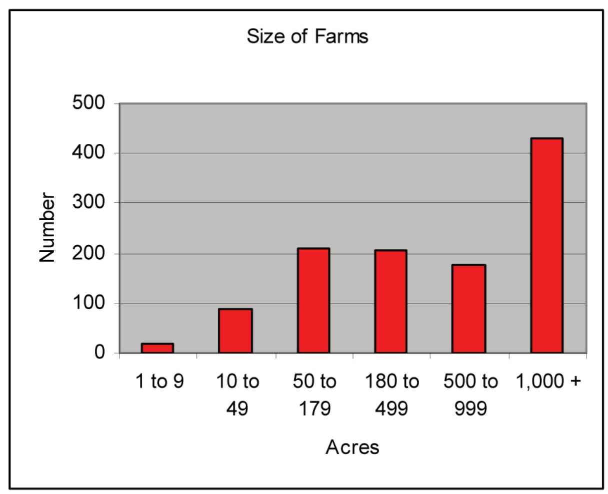
Census and Social Data

Number of Farms: 1,128

Number of Operators:

- Average Age: 52
- Full-Time Operators: 77%
- Part-Time Operators: 23%





FINANCIAL INCENTIVES AND TECHNICAL ASSISTANCE FOR LANDOWNERS:

Rotational Grazing Systems

* Landowner agrees to a managed rotational grazing system approved by NRCS. (i.e. twice-over, switch back, etc.)
* No Minimum acreage is required.
* Pays 40-80% of the cost of fencing materials and water developments needed to implement rotational grazeing systems.
* 10 year agreements.

Wetland Restorations

* One-time payments based on county rental rates for restoring wetlands. (state regulated)
* 100% of dirtwork costs will be paid by Fish & Wildlife Service to contractors or private landowners willing to do the work.
* 10 year agreements.

Wetland Creations

* fedral cost share up to $1000/surface acre to install dams for creating wetlands.
* Shallow wetlands preferred (less than 5 feet deep).
* May be used as a livestock watering facility.
* Pays up to 100% of the costs for project that create several acres of wetlands.
* 20 year agreements.

Grassland Easements

Vast grasslands once covered much of North America. Settlement, agriculture and development have reduced prairie grassland habitats to small isolated patches of grasslands. Loss of grassland is detrimental to wildlife as well as people. Grasslands help reduce soil erosion by wind and water, filter chemicals which help protect water supplies, and trap snow and rain to recharge our ground water. Grasslands provide forage for livestock as well as valuable habitat for food, cover and nesting sites for many species of migratory birds and wildlife. (Shultz 1999)

Grassland easements are signed agreements with landowners to temporarily or permanently keep land in grass. The majority of these easements are usually areas that exhibit steep and rocky topography considered by many to be marginal land for crop production and are best suited for livestock pastures. Landowners receive significant payments to keep these grasslands intact. Grassland easements restrict landowners from cultivating and/or developing these areas, and delay mowing, haying and seed harvesting until July 15 of each year. This restriction helps grassland nesting species to complete their nesting before the grass is disturbed. Grazing is not restricted in any way. (USDA Native Pririe Management)

* Payments can be estimated at approximately 30% of the fair and true value which is used by the county for tax purposes.
* Grasslands enrolled in this program may not be cultivated is some cases.
* Mowing, haying, and grass seed harvesting are allowed after July 15 annually.
* Grazing is not restricted in any way.
* Perpetual agreement.

Wetland Easements

In 1958, Congress amended the Migratory Bird Hunting and Conservation Stamp Act (the Duck Stamp Act), which authorized the U.S. Fish and Wildlife Service's Small Wetland Acquisition Program. Under this program, the Service has protected well over 2 million acres of wetland and grassland habitat, mostly in the duck producing areas of the Dakotas. (USFWS)

Wetland easements are signed agreements between private landowners to permanently protect valuable wetlands. The landowner receives a one-time payment; protected wetland basins cannot be drained, burned, filled, or leveled. When these wetlands naturally dry up, they can be farmed, grazed or hayed. The land remains in private ownership, remains on the tax rolls, and the landowner controls access.

* All wetlands are eligible. See handout.
* A one-time lump-sum payment is made based on a fair market value appraisal.
* Wetlands covered by an easement cannot be drained, filled, leveled, or burned.
* Wetlands can be farmed, grazed, or hayed when they dry up naturally.
* Perpetual agreement.

Grass Seeding

* 40-100% of the cost of grass seed will be paid to plant cropland to grass.
* Planted field must be delayed from haying until after July 15 or be part of a managed grazing system.
* Minimum 10 year agreements on tame grasses and 20 years on native grass. (USDA)

Hunting in North Dakota

According to the Congressional Sportsmen's Foundation

- Each year 139,000 people hunt in North Dakota, spending over a hundred million dollars on lodging, food, gas, and gear while paying over $10.5 million in state taxes.

**To put this in perspective, the taxes paid by hunters could pay 360 North Dakota teachers' salaries or fund the annual education expenses for 1,358 North Dakota students.

- The $103 million dollars spent by North Dakota hunters each year is one-third the cash receipts from soybeans, one of the state's top agricultural commodities.

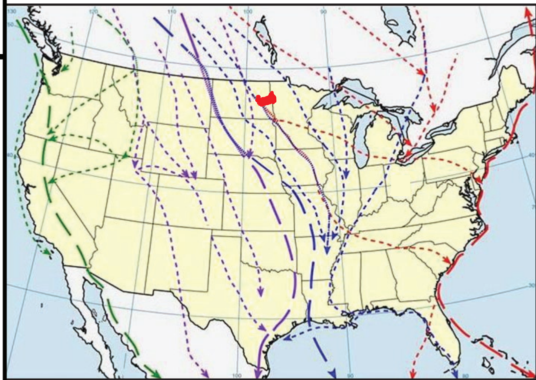
- "Hunters directly support more jobs in North Dakota than many of the state's biggest employers - over 3,000 jobs - and indirectly support thousands more!"

** *Rudie Martinson, Executive Director of the North Dakota Hospitality Association*

- Tourism is the second largest industry in North Dakota as well as sustaining 29% of the states economy.

Design Development

Continental Variables

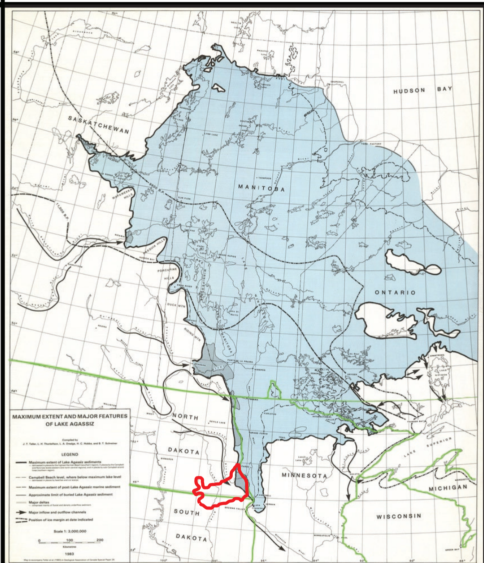


Pacific Flyway
Central Flyway
Mississippi Flyway
Atlantic Flyway

The sites connection to ecological and social processes on a continental scale:

- Migratory Bird Flyways
- Continental Divide
- Soil fertility and food production, America's "Bread Basket"

Regional Variables

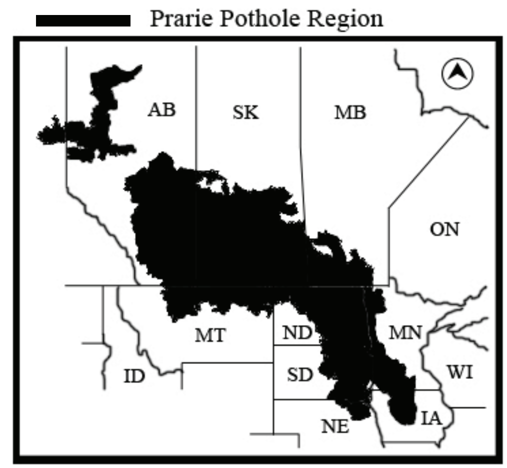


** Agassiz Map - Teller, J. T., L. H. Thorleifson, L. A. Dredge, H. C. Hobbs and B. T. Schreiner. Maximum Extent and Major Features of Lake Agassiz [map]. 1:3,000,000. In: Geological Associationof Canada. Special Paper 26. [Ottawa]: Geological Association of Canada, 1983

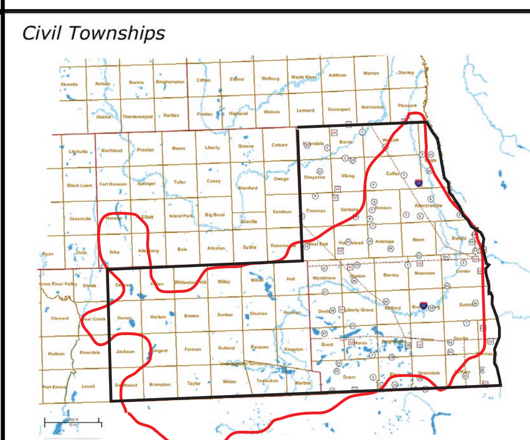
Ancient Lake Agassiz
Present Day State Boundaries
Western Rice Creek Watershed

The sites connection to ecological and social processes on a regional scale:

- Red River Valley Flood Plain
- Agassiz Lake bed soils and deltaic topography
- Cycles of glaciation
- Prairie pothole region
- Midwest Great Plains ecosystem
- Regional weather, seasonal shifts, and disturbance regimes.



Local Variables

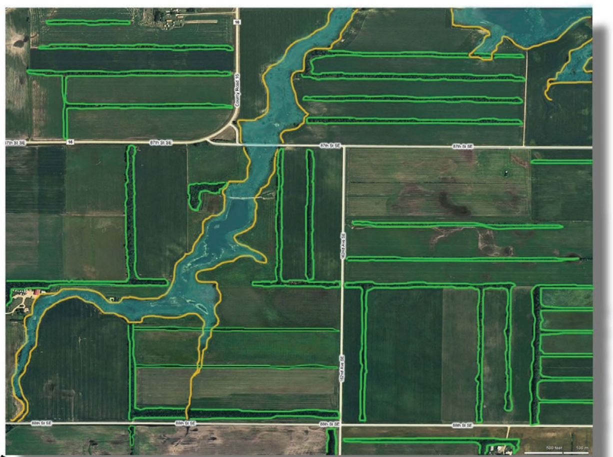


The sites connection to ecological and social processes on a local scale:

- Proximity to nationally protected lands: Sheyenne National Grasslands, Tewaukon Nature Refuge
- South East North Dakota agriculture, farm size, and crop intensity
-Local flora and fauna including invasive, endemic and keystone species.
- Localized Flooding

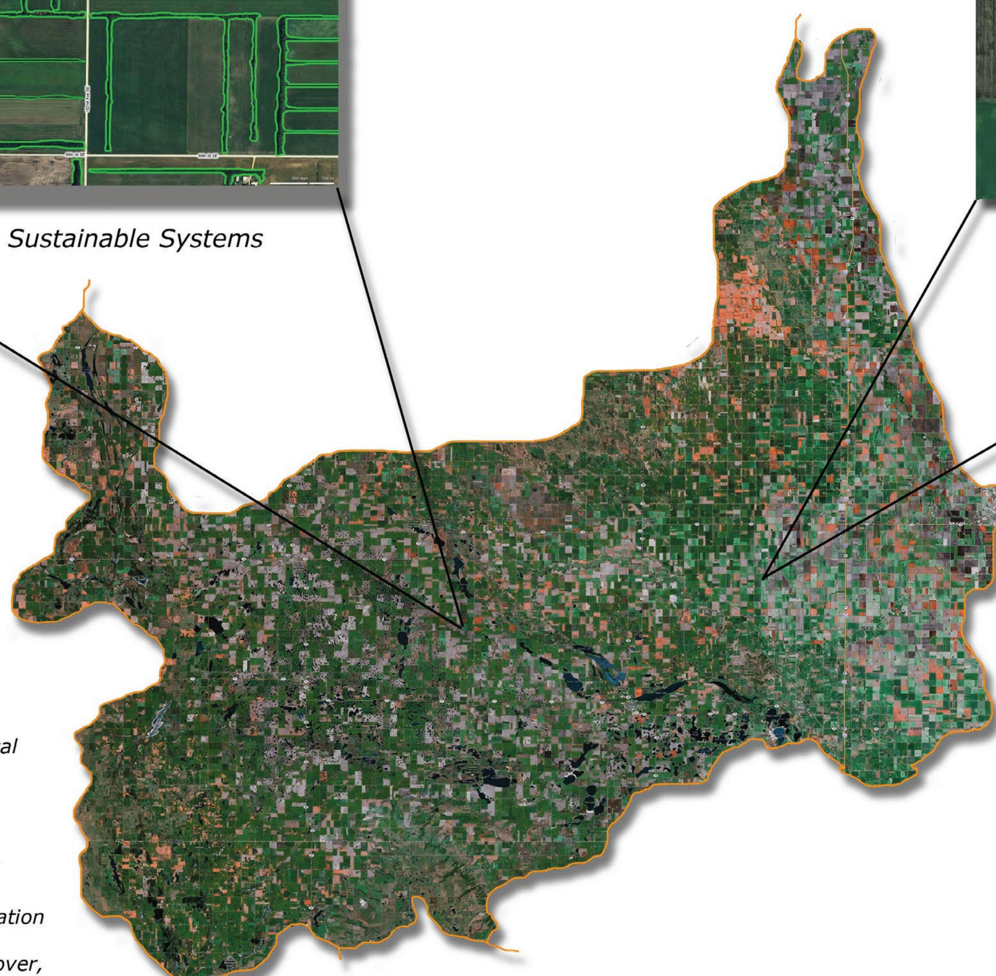
Dominant Water Bodies
Present Day Township Boundaries
Western Rice Creek Watershed
County Boundary

Sustainable Agriculture Practices



Existing Sustainable Systems

Existing Degraded System



Techniques:

Larger Riparian Buffer
- *Greater Biodiversity*
- *More stable embankments*
- *Less soil erosion and sedimentation*
- *Incoming nutrient filtration*
- *Existence of a stabile ecological corridor*

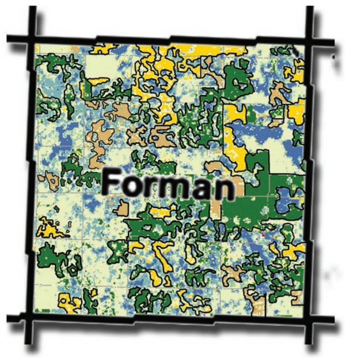
Utilization of trees rows
- *Less wind erosion of soils and biota*
- *Entrapment of winter precipitation (snow/ice)*
- *Creation of habitat, vertical cover, and small but usable ecological corridors.*

Techniques:

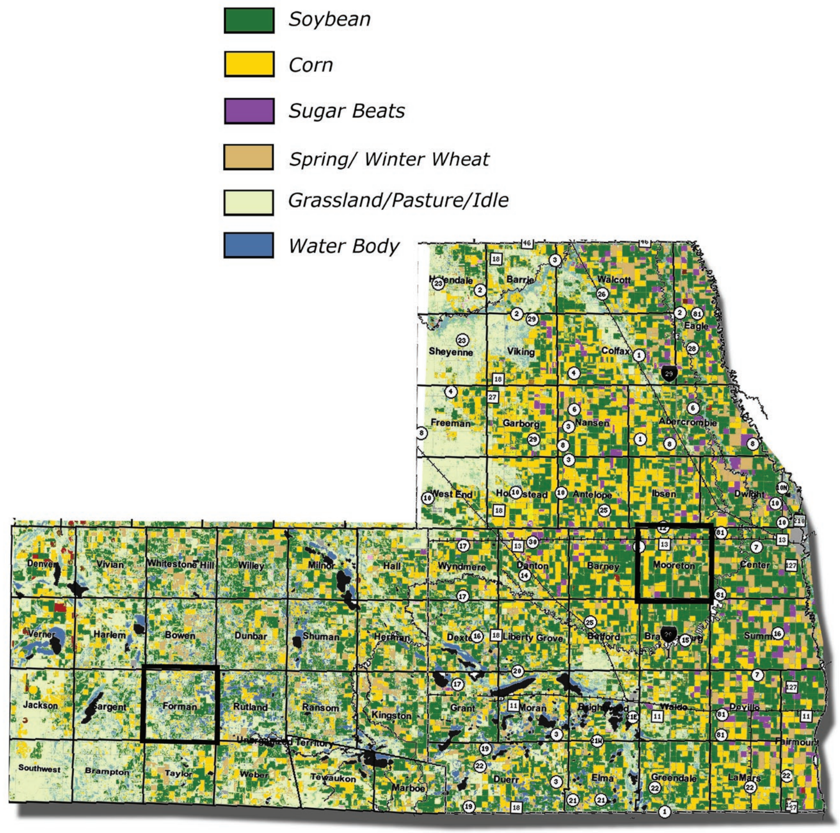
Narrow Riparian Buffer
- *less Biodiversity*
- *degraded embankments and greater seasonal overflow*
- *greater soil erosion and sedimentation*
- *little to no incoming nutrient filtration*
- *lack of a stabile ecological corridor*

Under Utilization of Tree Rows
- *Much greater wind erosion of soils and biota*
- *No protection or Entrapment of winter precipitation (snow/ice)*
- *Lack of habitat, vertical cover, and small but usable ecological corridors.*
- *Larger tracts of plant species mono-cultures.*

Passive Agriculture



Intensive Agriculture



Greater hydrologic features

Greater transitional space from aquatic systems to upland systems

Greater space for natural dynamics and ecological succession in transition areas

Greater resilience and ecological function within the given area and

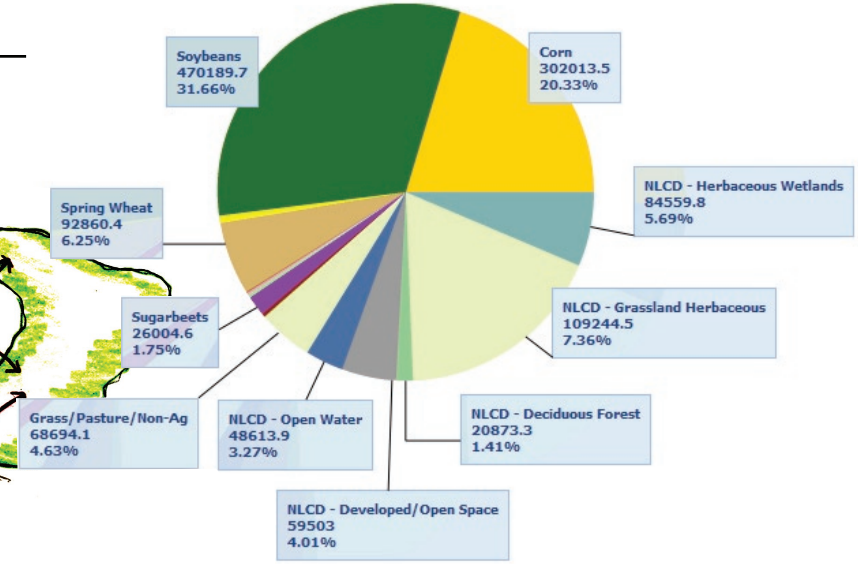
Greater agricultural cultivation, disturbance regime, and external nutrient pulses

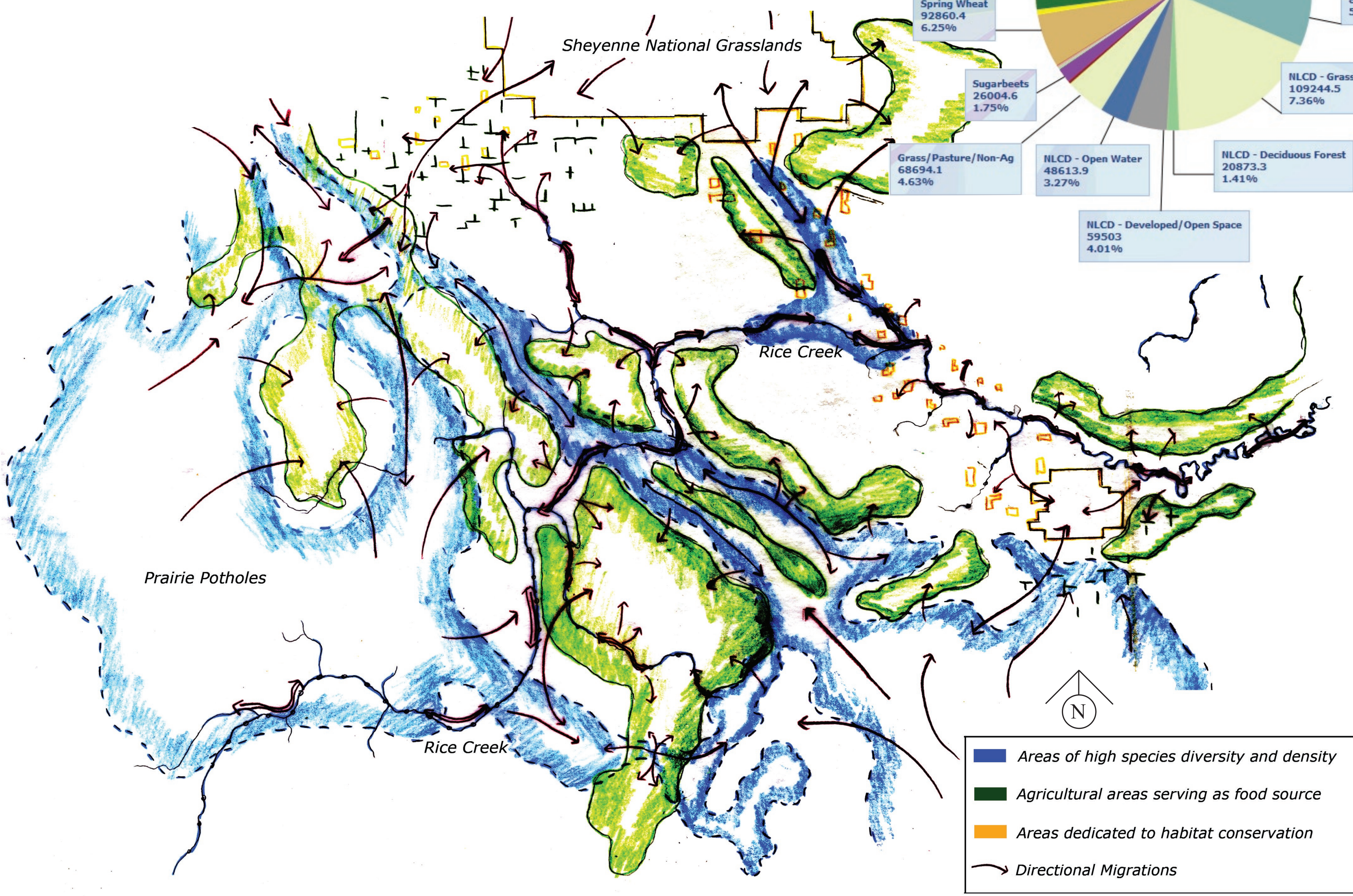
Less Idol land or hydrologic features for ecological function

Less open land for free succession, and higher biodiversity

Less resilience and greater need for human stewardship.

ABUNDANT IDOL CROP LAND CONNECTIONS TO AGRICULTURAL FEEDIONG AREAS





Utilizing Anthropomorphic Systems and Development For Resilience . . .

Utilizing The Grid

Use North Dakota's mass roading to foster ecological resiliency.

- "Road Corridors"
- "Ditch Ecology"

Land Parceling

- Plantings used for identification.
- Tree Row development leads to erosion resistance from wind and water .
- Movement corridors for wildlife.

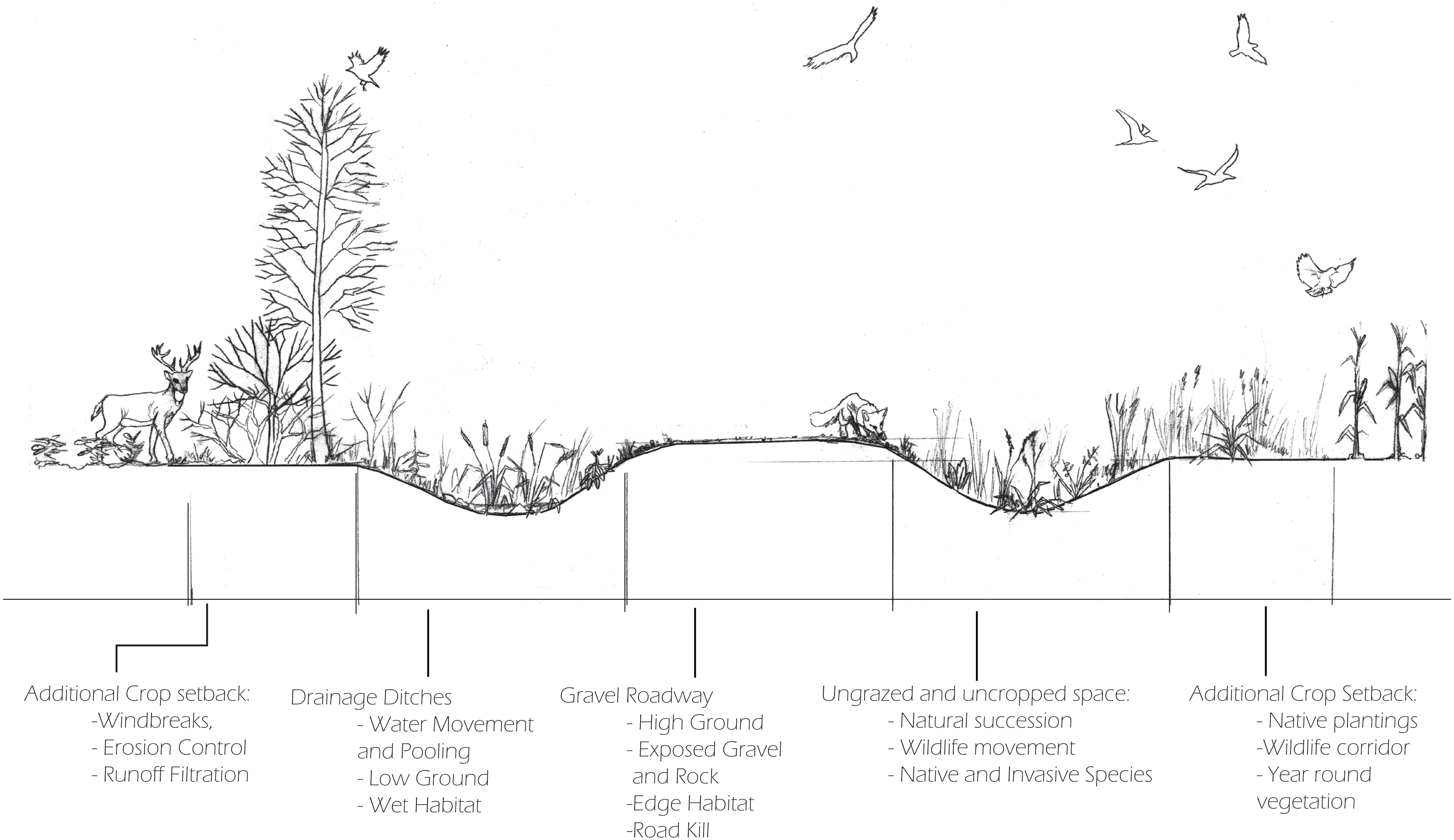
Invasive Species Resistance

- Roads, large tree lines, and built infrastructure that define the grid serve as barriers to invasive species.
- "Waffle Compartment" method.

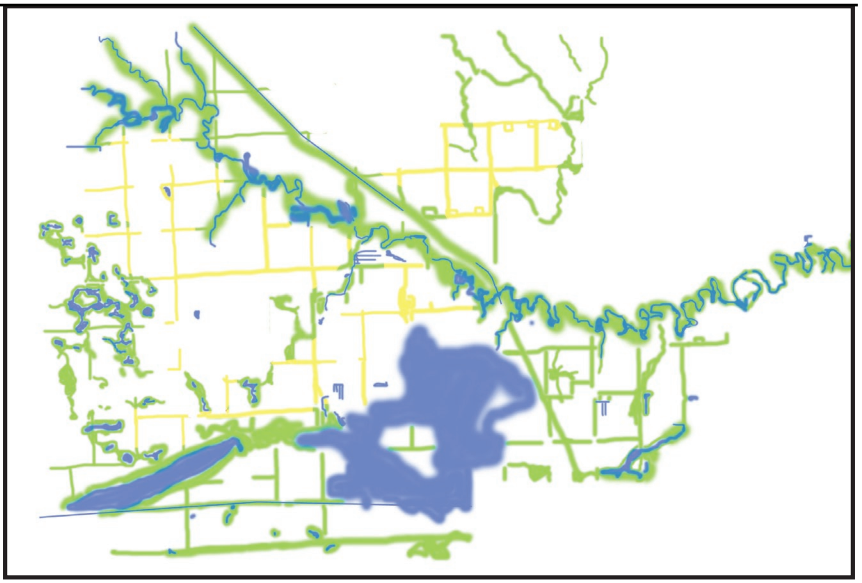
Farmstead Oasis

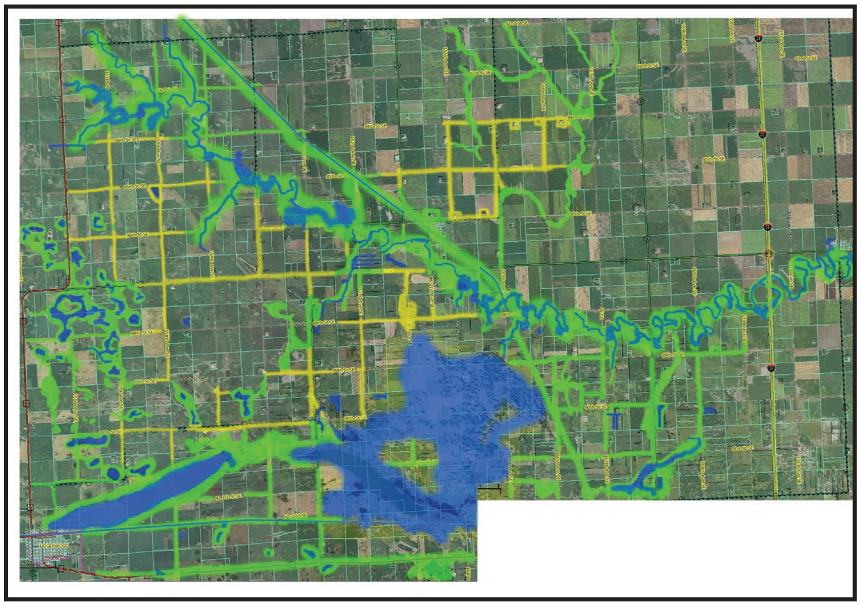
- With gardens, Trees, and perennials peoples homes and farmsteads have become little oasis for biodiversity and wildlife on a number of scales.
- Intensive plantings to border farmsteads and around ranch buildings.
- Runoff filtration of contaminants found around housing and construction.
- Evokes a sense of place for living on the prairie

Ditch ecology



Ecological connectivity Map

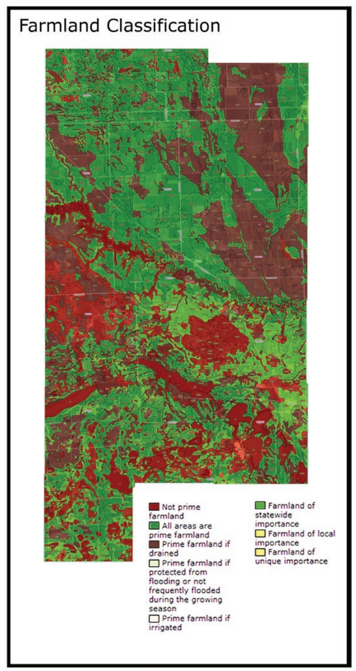


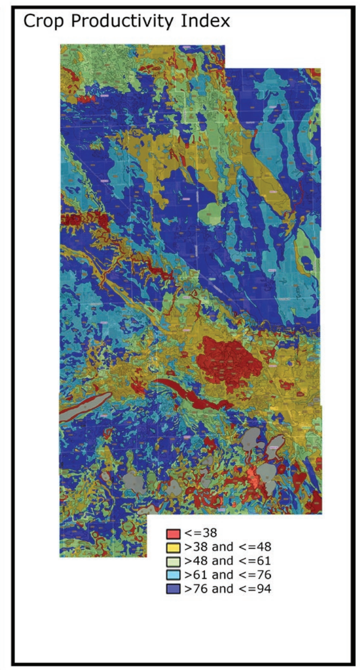


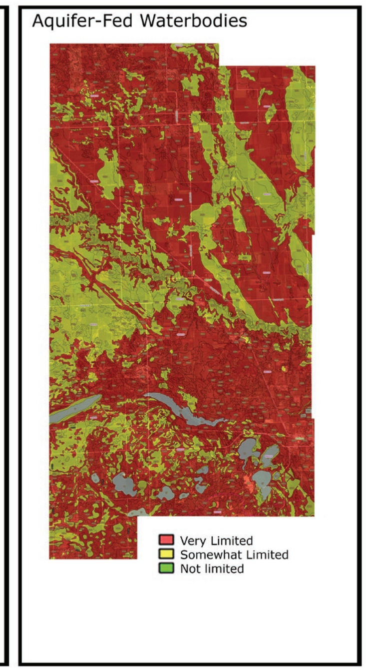
Connective Corridors
Existing Ecologically Productive Areas

Gamma Biosphere Level

At this level the management plan closely resembles the divers landscape mosaic important for ecology at this scale. Outlines important areas (existing and proposed) that foster ecological sustainability and resiliency; as well as the corridors that connect them. The areas also designate conditions that show degradation, damaging inundations, and saline conditions



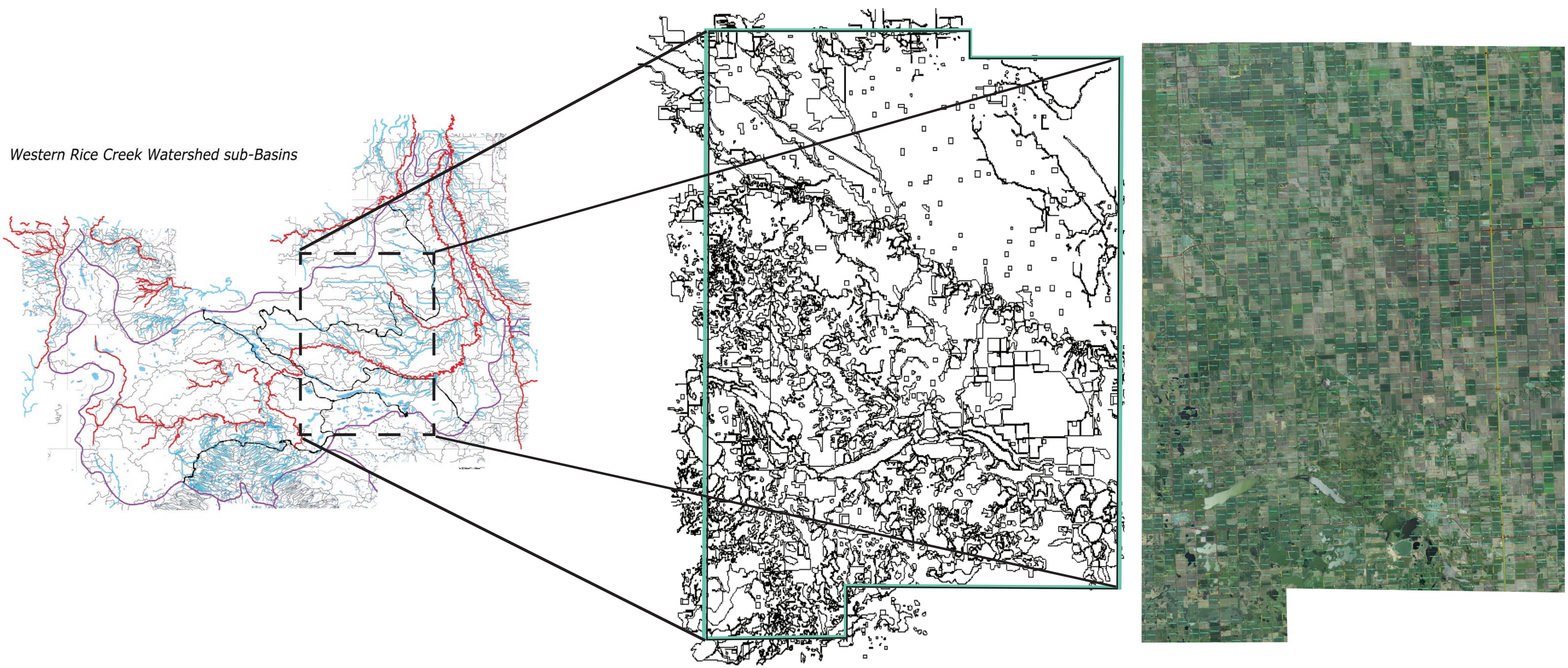




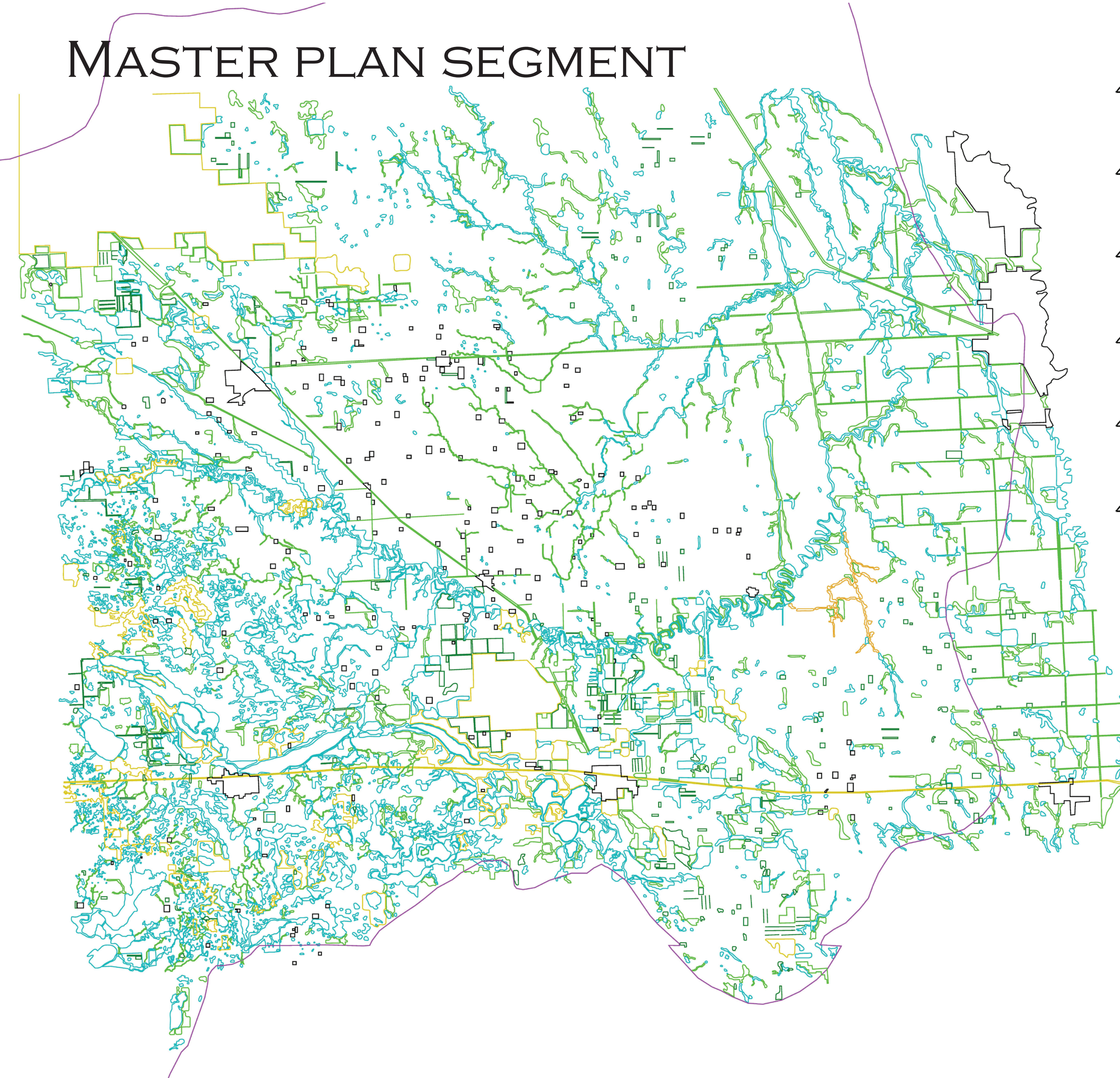
Important multi-layered mapping to designate important conditions on a site by site level.

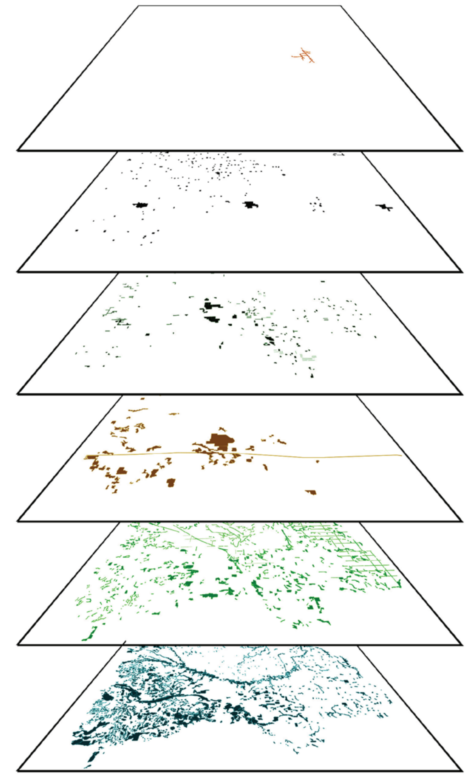
Ecological Hierarchy For Management plan

1) Wildlife Movement and Resilience
2) Plant Resilience - crops and wild species
3) Resistance to Invasive Species
4) Cleaner Water

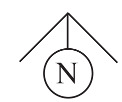


Master plan segment





Zoning boundaries are based on land uses specified by exiting CRP (conservation reserve program), PLOTS, and WRP (Wetland reserve Program) governmental programs.



Each color determines the inherit nature of the program that is proposed for that area.

Upland Plantings

For areas often removed from hydrological systems but are still vital to diversity and multisystem management. Panting legumes, grasses and other herbaceous perennials for a variety of habitat conditions as well and biological remediation if desired.

Forest Plots and Tree Rows

A variety of connective interventions within the plan that add the ecological strength and resilience by tree planting and developing mature productive areas of hardwood trees. This enhances resilience greatly by reducing erosion, pollutants, retaining energy within the system, and unique habitat used by many species.

Habitat Restoration

These are areas that either, already exist as important areas for wildlife production, or they have the potential to become one. More requirement are need and a more intense management plan is need but cost sharing also increases along with the resiliency addition from diverse sections of specific habitat.

Bioremediation and Salinity Treatment

Certain areas within this watershed a greatly degraded do to increased saline conditions in their soils. Areas designated in this category are areas where bioremediation or saline treatment is taking place. Also incorporates the creation of special saline designated ares to foster biological succession in a saline ecosystem.

Hydrological Modification

Obviously this category includes all this incorporating water from lakes, ponds, and rivers, to swales, farmable flood plains and grazeable shoreline.

MOSAIC OF MANAGEMENT AREAS

Practice Code	Practice Narrative	Contract Length	Financial Help C/S1/	PIP	SIP3/
CP1	Introduced Grasses and Legumes	10 yr	50%	40% 2/	
CP2	Native Grasses	10 yr	50%	40% 2/	
CP3	Block Tree Planting	10 yr	50%	40% 2/	
CP3A	Hardwood Tree Planting	10-15 yr	50%	40% 2/	
CP4B	Wildlife Corridors	10-15 yr	50%	40% 2/	
CP4D	Wildlife Habitat	10 yr	50%	40% 2/	
CP5A	Field Windbreaks	10-15 yr	50%	40%	yes
CP8A	Grassed Waterway	10 yr	50%	40%	yes
CP9	Shallow Water Area For Wildlife	10 yr	50%	40%	
CP10	Established Vegetation	10 yr			
CP12	Wildlife Food Plot	10-15 yr			
CP15A	Contour Grass Strips	10 yr	50%	40%	
CP15B	Estb. Perm. Veg. Cover (Grass Strips) on Terraces	10 yr	50%		
CP16A	Shelterbelts (Farmstead Windbreaks)	10-15 yr	50%	40%	yes
CP17A	Living Snow Fences	10-15 yr	50%	40%	yes
CP18B	Perennials to Reduce Salinity (Seeps & Recharge)	10 yr	50%	40%	
CP18C	Estb. Salt Tolerant Plants (Saline Soils)	10 yr	50%	40%	
CP21	Filter Strips	10-15 yr	50%	40%	yes
CP22	Riparian Buffers	10-15 yr	50%	40%	yes
CP23	Wetland Restoration	10-15 yr	50%	40%	yes
CP23A	Wetland Restoration - Non-Floodplain	10-15 yr	50%	40%	yes
CP24	Cross Wind Trap Strips	10 yr	50%	40%	
CP25	Rare and Declining Habitat	10-15 yr	50%	40%	
CP27	Farmable Wetlands	10-15 yr	50%	40%	yes
CP28	Farmable Wetland Buffer	10-15 yr	50%	40%	yes
CP29	Marginal Pastureland Wildlife Habitat Buffer	10-15 yr	50%		yes
CP30	Marginal Pastureland Wetland Buffer	10-15 yr	50%		yes
CP31	Bottomland Timber Establishment on Wetlands	10-15 yr	50%	40%	yes
CP37	Duck Nesting Habitat	10-15 yr	50%	40%	yes
CP-41 6/	Flooded Prairie Wetlands	10-15 yr	50%	40%	yes
CP38	State Acres for Wildlife Enhancement (SAFE)	10-15 yr	50%	40%	yes

Four primary goals of the Conservation Reserve Program (CRP) are to reduce erosion, improve water quality, enhance wildlife, and improve air quality. CRP is administered by the Farm Service Agency, a conservation partner of NRCS; however, NRCS provides technical assistance and some promotional assistance to the program as well. CRP is a voluntary program in which farmers and ranchers enter into 10- to 15-year contracts with USDA to take highly erodible land and other environmentally sensitive cropland out of production by applying protective vegetative cover best suited for wildlife. In exchange, landowners receive annual rental payments for the land and cost-share assistance for establishing conservation practices. The program protects the Nation's most environmentally sensitive cropland.

Existing CRP, WRP, and Safe Programs

Richland County, ND

CRP & SAFE Practice Summary

{For complete details refer to the FSA Handbook 2-CRP (Rev. 4}
http://www.fsa.usda.gov/FSA/

revised 2-17-09

Practice Code	Practice Narrative	Contract Length	Financial Help C/S1/	PIP	SIP3/	Pract-ices for SAFE	Any Eligi-ble Acres	Only Wellhead Protection Areas	% Rental Incent-ive	Consid-erations and/or Restric-tions	Mid Contract Mgmt. Options 4/
CP1	Introduced Grasses and Legumes	10 yr	50%	40% 2/				✓	5/ 10%		* 1,2,3,4,5,6,10
CP2	Native Grasses	10 yr	50%	40% 2/		X,Y,Z		✓	5/ 10%		* 1,3,4,5,6
CP3	Block Tree Planting	10 yr	50%	40% 2/				✓	5/ 10%		7
CP3A	Hardwood Tree Planting	10-15 yr	50%	40% 2/				✓	5/ 10%		7
CP4B	Wildlife Corridors	10-15 yr	50%	40% 2/				✓	5/ 10%		*
CP4D	Wildlife Habitat	10 yr	50%	40% 2/		Y		✓	5/ 10%		* 1,2,3,4,5,6,10
CP5A	Field Windbreaks	10-15 yr	50%	40%	yes		✓		20%	J	7
CP8A	Grassed Waterway	10 yr	50%	40%	yes		✓		20%		1,5,6
CP9	Shallow Water Area For Wildlife	10 yr	50%	40%			✓				
CP10	Established Vegetation	10 yr				X,Y,Z		✓	5/ 10%		* 1,2,3,4,5,6,10
CP12	Wildlife Food Plot	10-15 yr				X,Y,Z				B	
CP15A	Contour Grass Strips	10 yr	50%	40%			✓				
CP15B	Estb. Perm. Veg. Cover (Grass Strips) on Terraces	10 yr	50%				✓				
CP16A	Shelterbelts (Farmstead Windbreaks)	10-15 yr	50%	40%	yes		✓				7
CP17A	Living Snow Fences	10-15 yr	50%	40%	yes		✓			K	7
CP18B	Perennials to Reduce Salinity (Seeps & Recharge)	10 yr	50%	40%			✓			H,M	1,3,4,5,6,10
CP18C	Estb. Salt Tolerant Plants (Saline Soils)	10 yr	50%	40%			✓			I,M	* 1,3,4,5,6,10
CP21	Filter Strips	10-15 yr	50%	40%	yes		✓		20%	N	1,4,5,6
CP22	Riparian Buffers	10-15 yr	50%	40%	yes		✓		20%	O	7
CP23	Wetland Restoration	10-15 yr	50%	40%	yes		✓		20%	F,P	1,2,3,4,5,6,10
CP23A	Wetland Restoration - Non-Floodplain	10-15 yr	50%	40%	yes	X,Y	✓		20%	C,D	1,2,3,4,5,6,10
CP24	Cross Wind Trap Strips	10 yr	50%	40%			✓			A	
CP25	Rare and Declining Habitat	10-15 yr	50%	40%		X,Y					1,3,5,6
CP27	Farmable Wetlands	10-15 yr	50%	40%	yes	X,Y	✓		20%	D,L	1,5,6
CP28	Farmable Wetland Buffer	10-15 yr	50%	40%	yes	X,Y	✓		20%	D,G	1,3,4,5,6,10
CP29	Marginal Pastureland Wildlife Habitat Buffer	10-15 yr	50%		yes		✓		20%	Q	1,4,5,6
CP30	Marginal Pastureland Wetland Buffer	10-15 yr	50%		yes		✓		20%	Q	1,4,5,6
CP31	Bottomland Timber Establishment on Wetlands	10-15 yr	50%	40%	yes		✓		20%	F	7
CP37	Duck Nesting Habitat	10-15 yr	50%	40%	yes	X,Y	✓		20%	E	1,2,3,4,5,6,10
CP-41 6/	Flooded Prairie Wetlands	10-15 yr	50%	40%	yes		✓		20%	D,L	1,2,3,4,5,6
CP38	State Acres for Wildlife Enhancement (SAFE)	10-15 yr	50%	40%	yes	see above	✓	*(X) Tall grass prairie*		varies by practices chosen	1,2,3,5,9
								(Y) Coteau / Drift prairie			1,2,3,5,9
								(Z) Sage Grouse			8

1/ C/S = 50% cost share of eligible expenses
2/ PIP = Practice Incentive Payment is 40% of eligible practice establishment costs.
3/ SIP = Signing Incentive Payment is $100/acre on eligible continuous signup practices.
4/ Specific management practices must be applied 1 time within the life of the contract. In most cases, emergency or managed haying and grazing will fulfill mid contract maintence requirements. For specific mid contract requirements refer to Exhibit 8 of the 2CRP Manual or ftp://ftp-fc.sc.egov.usda.gov/ND/CRP/crp_req_mgmt.pdf.
5/ 10% rental incentive applies only within a well head protection area.
6/ Program has not been implemented at time of publication.

Note: SIP payments do not apply to reenrollments.

* = May be eligible for emergency haying and

Statewide Acreage Limits

CP-23	1000 acres
CP-23A	65,000 acres
CP-27, 28	100,000 acres
CP-31	1000 acres
CP-37	40,000 acres

Considerations / Restrictions Explaination

A = Total practice (≥ 2 strips) acres cannot exceed 10% of individual field.
B = Food plots shall not exceed 5 acres in size. If used to calculate eligibility points they must be maintained for the life of the contract.
C = Must be cropland located outside the 100-year flood plain of a permanent river or stream.
D = Buffer to wetland ratio must not exceed 4:1.
E= Buffer to wetland ratio must be at least 4:1 but not exceed a buffer to wetland ratio of 10:1.
F = Must be cropland located within the 100-year floodplain of a permanent river or stream.
G= Minimum buffer width Is 30 feet.
H = 50 acres maximum unless site visit shows a need for more.
I = 50 acre maximum, no exceptions.
J = 3 rows maximum.
K = 5 rows maximum.
L = Must be enrolled with CP28.
M = Salinity of discharge soils and seeps must be > 4 mmhos/cm.
N = Average filter strip width must be 20'-120'.
O = Average riparain forest buffer width must be 35'-180'.
P = Buffer to wetland ratio cannot exceed 3:1.
Q = Site not eligible if livestock exclusion solves the problem.

Mid Contract Required Management Options 4/

(Cost share assistance may be available for some options)

1 =Clip & Remove - Between Aug. 2 and Sept. 1. ≤ 50% of field
2 = Disking - <4" deep. Must leave 30% residue. ≤ 50% of field Disk prior to April 15 or between August 2 and September 1.
3 = Heavy harrow - ≤ 50% of field Harrow prior to April 15 or between August 2 and Sept. 1.
4 = Interseeding Legumes or Forbs Limited to stands with canopy cover < 15% legumes/forbs.
5 = Prescribed burning - Burning permits may be required. Conduct prior to April 15 or between Aug 2 and September 1.
6 = Chemical Herbaceous Vegetation Control Apply at appropriate time. Not for noxious weed control.
7 = Fabric Management - Inspect and apply 4-5 yrs. after planting Enlarge openings, slice or remove fabric.
8 = Managed Grazing - Recommended but not required.
9 = Interseed Legumes
10 = Lawson Aerator - ≤ 50% of field. Prior to April 15 or between Aug 2 and Sept 1.

** CRP - Conservation Reserve Program
WRP - Wetland Reserve Program
SAFE - State Acres for Wildlife Enhancement

Public use and GIS Integration

The Final Master Plan of the Connective Management Plan becomes an integrated data layer to be distributed to the public either via GIS technology or Governmental institutional control (USDA, USGA, Fish and Wildlife service). From there they are provided a spread sheet of program cost and associated requirements for applicant (planting list, excavation, weed control sprays). Property owners can chose one of multiple option in addition to the option of keeping land at its current state.

Any land owner within the watershed and surrounding counties can search their parcel number or name to see if they have any land available for wildlife management cost sharing. A read out of total acreages effected by the plan, and by what program, are available to the property owner.

Comparison Of EQIP and Continuous CRP For A 2-acre Waterway

The **example** shown is based on a two-acre waterway in central ND. **For each specific site, actual expenses, cost share, and incentive payments will vary,** depending on excavation volume, grass varieties planted, vendor's prices, soil types, local rental rates, whether or not mulch is applied, etc.

Installation Component	Number of Units	Est. Cost Per Unit	Est. Total Project Cost	EQIP Cost-share *(50% basis)*	Continuous CRP Cost-share Plus Practice Incentive Payment
Earthwork- cubic yards excavated	1700	$2.10	$3,570.00	$1,785.00	$3,213.00
Temporary Cover, acres- *(plant small grain with drill for temporary erosion control)*	2	$20.00	$40.00	$20.00	$36.00
Seedbed preparation - *(spray glyphosate before grass seeding)*	2	$17.43	$34.86	$17.43	$31.37
Seeding operation, acres	2	$11.00	$22.00	$11.00	$19.80
Seed- pounds of switchgrass	7	$2.50	$17.50	$8.75	$15.75
Seed- pounds of western wheatgrass	16	$4.75	$76.00	$38.00	$68.40
Mechanical weed control, acres	2	$7.00	$14.00	$7.00	$12.60
Signing incentive payment, $100/ ac.				none	$200.00
Total installation cost / reimbursement		=	***$3,774.36***	***$1,887.18***	***$3,596.92***

Annual Payment - amounts shown are for the total 2-acre contract area.	EQIP	Continuous CRP
Land rental - varies by soil type and county rental rate. (avg $40)	none	$80.00
Rental incentive payment *(20% of land rental)*	none	$16.00
Total annual payment per year	none	$96.00
10-year Contract Total	***none***	***$960.00***

Program Comparison for Decision-making	EQIP	Continuous CRP
Out-of-pocket establishment cost to landowner	***$1,887.18***	***$177.44***
Net cost to landowner over life of contract	***$1,887.18***	none
Net return to landowner over life of contract	none	***$782.56***

Additionally, a gully problem has been fixed, water quality improved, soil productivity protected, and the area is now crossable with machinery.

This example illistrates the economic result of not haying or grazing waterways.

Phasing for CRP implimentation

Permanent Native Grasses and Vegitative Seeding

All CRP participants with contracts beginning with sign-up 26 are required to have management activities that are site specific and ensure; Plant diversity, Wildlife benefits, and Protection of soil and water resources.

Site Preparation:

A nurse crop may be used for spring seeded grasses and legumes for erosion control and weed suppression.

Max. 10 lbs./acre of oats or barley,or 7 lbs./acre of flax.

No companion crop is required for late summer seeding but it may be desirable for erosion control and to protect developing seedlings.

Companion crops shall be clipped prior to the boot stage to minimize competition with emerging grass and legume plants.

Seeding Dates:

Cover should be seeded within 12 months of the CRP contract's effective date. For cool season grass species mixtures see table below:

If legumes are part of a late summer seeding, the seed is to be planted by August 25.

Seed bed Preparation:

The seedbed must be essentially free of competing vegetation. A firm seedbed will allow for placement of the seeds at a depth of 1/4 to 3/4 of an inch into the soil. Seedbed preparation will be mechanical or chemical.

Seeding:

The seed may be planted with a grain drill or grass drill.

** Broadcasting seed does not meet practice specifications and is ineligible for cost share payments.

Seeding Depths:

Fine to Medium textured soil at 1/4 to 3/4 inch

Coarse textured soil at 1/2 to 1 inch

Season of Planting for Cool Season Species	Area of the State	
	North of North Dakota Hwy 200	South of North Dakota Hwy 200
Spring	Prior to May 20	Prior to May 10
Late Summer	Aug 10 to Sept 1	Aug 10 to Sept 15
Late Fall	After Oct 20	After Nov 1
Warm Season Species	May 10 – June 25	May 10-June 25
Warm/Cool Season Mix	May 1-June 15	April 20-June 1

- Operation and maintenance will include but not be limited to the following:

1. Control annual weeds and other competition the year of establishment, with early and timely clipping before seed heads appear, or mainly timely application of herbicides.

2. After the cover is established, prevent disturbance of cover during the primary nesting season for wildlife, which is April 15 through August 1st.

3. After cover is established, control all weeds to the extent they do not adversely impact the required cover or surrounding landowners by:
   a) Treating with chemicals per label directions not designated regulations,
   b) Spot mow before seed heads form.
      ** When possible, delay use of control measures until after August 1st to protect nesting wildlife.

4. Protect the acres from haying and grazing year round. Fences may need to be constructed and maintained to exclude livestock throughout all 12 months of the year.

5. Re-seed any areas that do not have adequate permanent cover.

6. Cannot use the contract area for field borders, field roads or other uses that will damage or destroy the cover.

7. Do not use the field for disposal of livestock or organic waste unless that use is authorized in the additional specifications and remarks.

- Management activities may include:

Light disking, Heavy harrowing, Clipping and removal, Prescribed burning, or Interseeding legumes will be done once a year.
Use of Pesticides

** Only those pesticides, which are labeled for the specific use, will be recommended. North Dakota State University and Extension publications and specific label instructions will be used for guidance on herbicide selection and use.

** Management of cover will be required once for ten-year contracts. The cover management activity for a ten-year contract must be completed before the eighth year of the contract. Cost share may be available for the management activity.

** The native grass cover must be established according to the practice specifications and the conservation plan. The specifications are prepared in accordance with the NRCS Field Office Technical Guide practice standard (327) Conservation Cover.

Design Examples of Important Environmental Mitigations

Because this large management plan is strongly based on public participation and cumulative efforts there is a very real possibility that a lack of interest, in the face of a number of conflicting interests, could become a major problem in the establishment of connective corridors. To ensure the success of important ideals inherit to the overall management approach, specific instances have been designed within the plan to serve as crucial footholds for the strengthening of the areas sustainability.

The Sheyenne Waterfowl Refuge

First is an off-steam retention wetland for duck habitat and flood control. The Sheyenne Waterfowl Refuge would be a state and federally purchased plot of unproductive, crop lowlands outside of the flood zone of the Wild Rice Creek for the sake of flood control within this specific sub-basin. The refuge will illustrate how to intensely and thoughtfully design habitats to more closely resemble natural forms and mosaics while still adhering to contextual ecology.

Great bend Cooperative saline System

Second is a collaborative saline soil treatment system for saline habitat retention that is feed by channelized flow from the Wild Rice Creek. This can be done through CRP saline programs or through a working land contract if a landowner wishes keep the effected land under private control. The Saline systems incorporates percolation techniques by gathering salt run-off from surrounding fields, along with regulated river inundation, to create a dedicated saline habitat to foster resilience while still functioning to lower water tables and treat unproductive crop land.

Pot Hole Consolidation

The other two designs are more exemplary techniques that can be applied to any and all landowners within the watershed either through solitary action of collaborative. The first technique is pot-hole consolidation, meaning the practice of draining unregistered and unproductive crop lowlands to a permanent and ecologically sustainable retention wetland. Techniques like simple grade changes or soil excavation to not only allow the land owner to operate a efficient grow harvest but instill techniques that create ecological resiliency and permanent reliable habitat.

Riparian Boundary restoration

The last design is an often overlooked practice of riparian embankment management. Not many trees are native or common to this region but in a newly emerging regime shift trees become a huge factor in the control of erosion from wind, water and animals as well as ecosystem services like biomass production, habitat existence, and bio filtration of nitrogen run-off from surrounding agricultural lands.

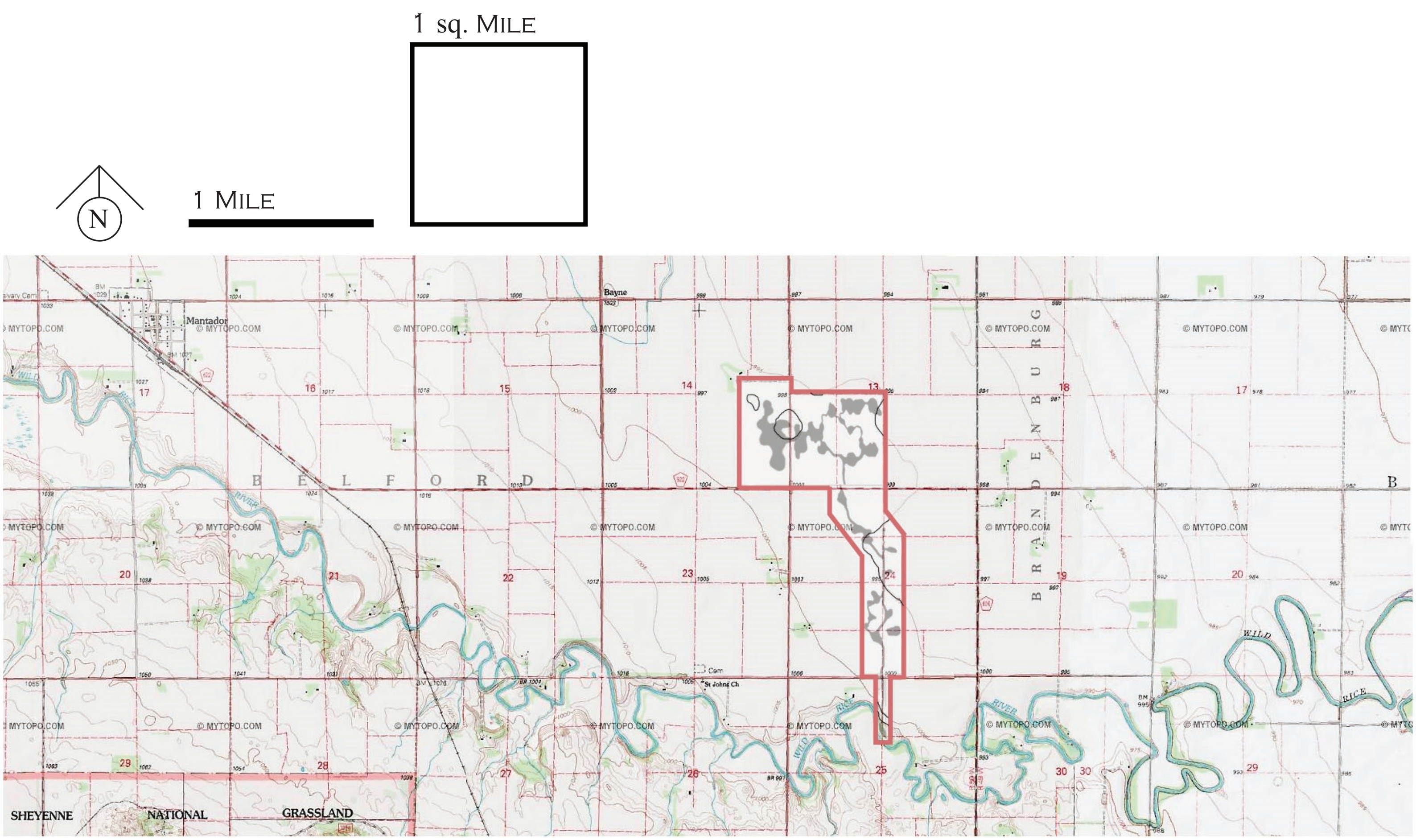
The Sheyenne Waterfowl Refuge

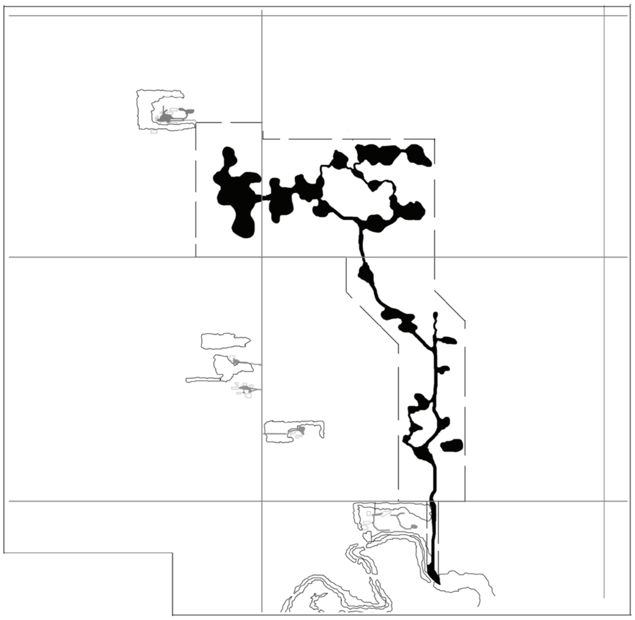
Off stream retention / Waterfowl habitat / Wetland Restoration

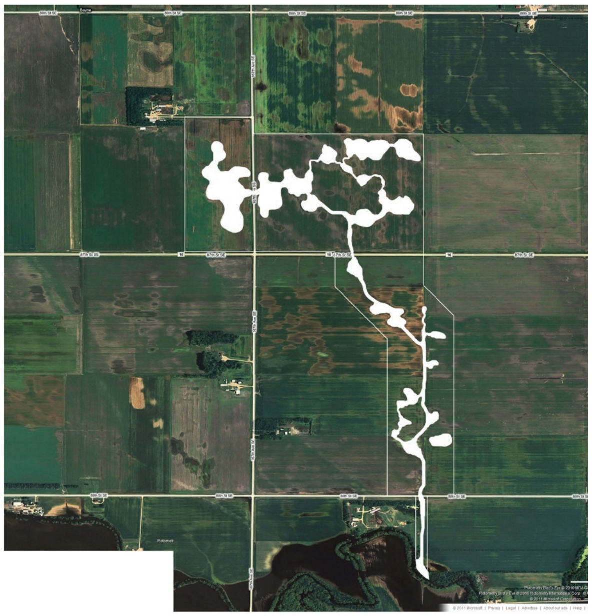
The Sheyenne Waterfowl Refuge is located in South Eastern North Dakota, approximately 3 miles east of Mantador, North Dakota, in Bedford Township, Richland County.

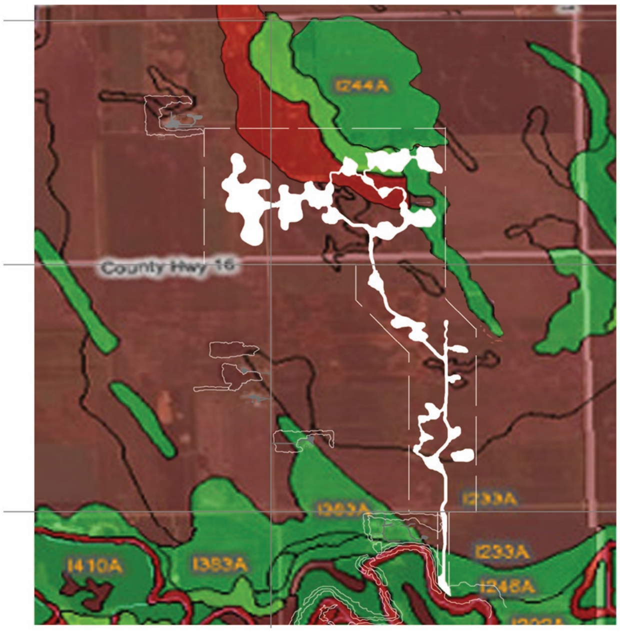
This cumulative 1.12 square-mile impoundment area will collect runoff from the Wild Rice River, within the Western Wild Rice Watershed, which drains to the Red River of the North. The project would provide floodwater storage for spring
runoff and summer rainfalls.

Approximately 716.8 acres of land, The project involves building a collection system to bring water into the impoundment, and partitioning the interior to provide a complex of subimpoundments. The impoundment will have 100% of its storage capacity available for the spring runoff. After spring runoff, the water will be released as quickly as possible to restore about 80% the impoundment's capacity. The remaining 20% will be drawn out slowly over the balance of the year while providing the secondary benefits.









Project Benefits:

- Flood Damage Reduction (Primary objective):

  Provides 700 acre feet of hydrological storage which is equivalent to 80% of the estimated 100 year spring runoff.

- Downstream Flow Augmentation:

  Release of about 5 cfs flow during the ice free season in most years.

- Water Quality:

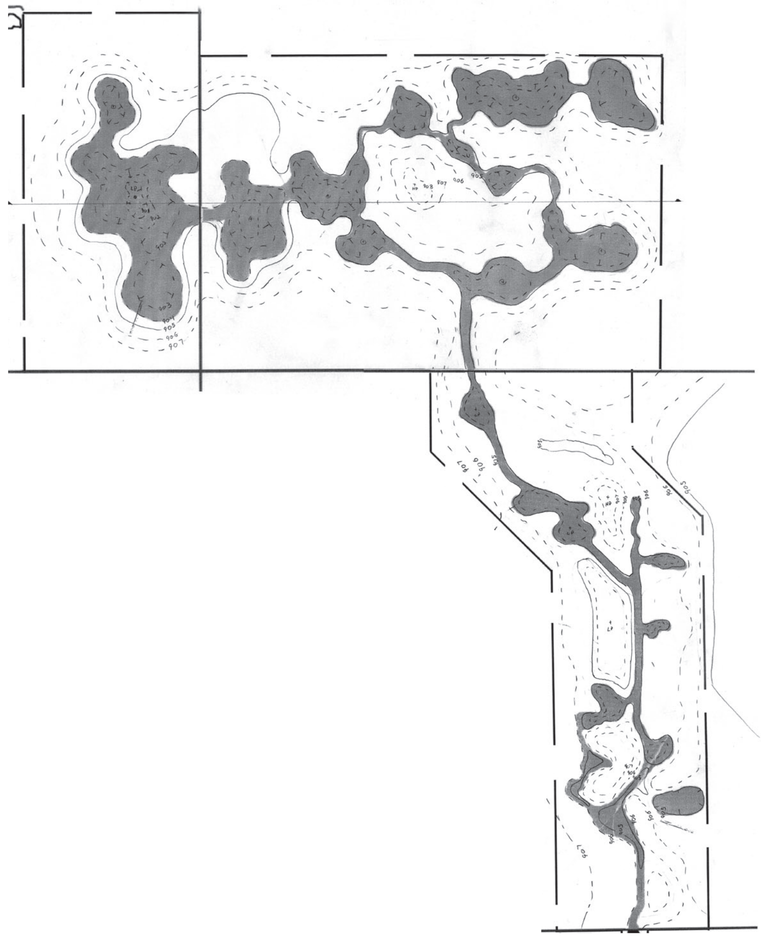
  Improvement via sedimentation and nutrient uptake by wetland plants

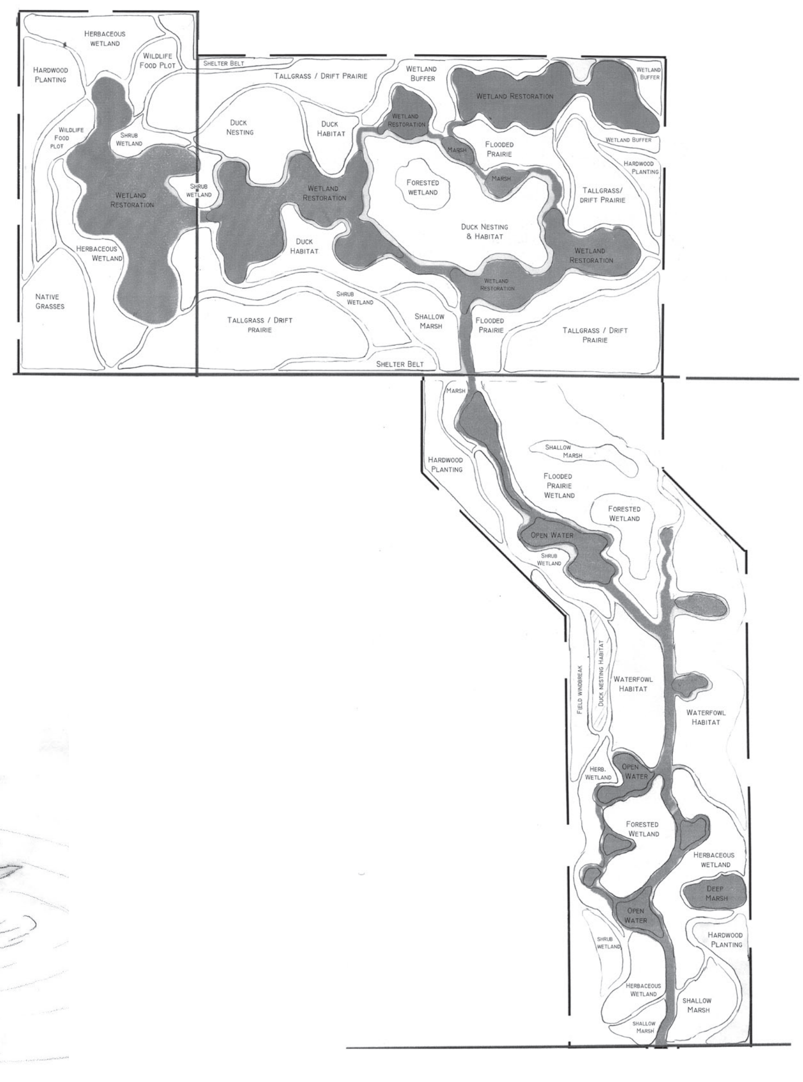
- Habitat Enhancement:

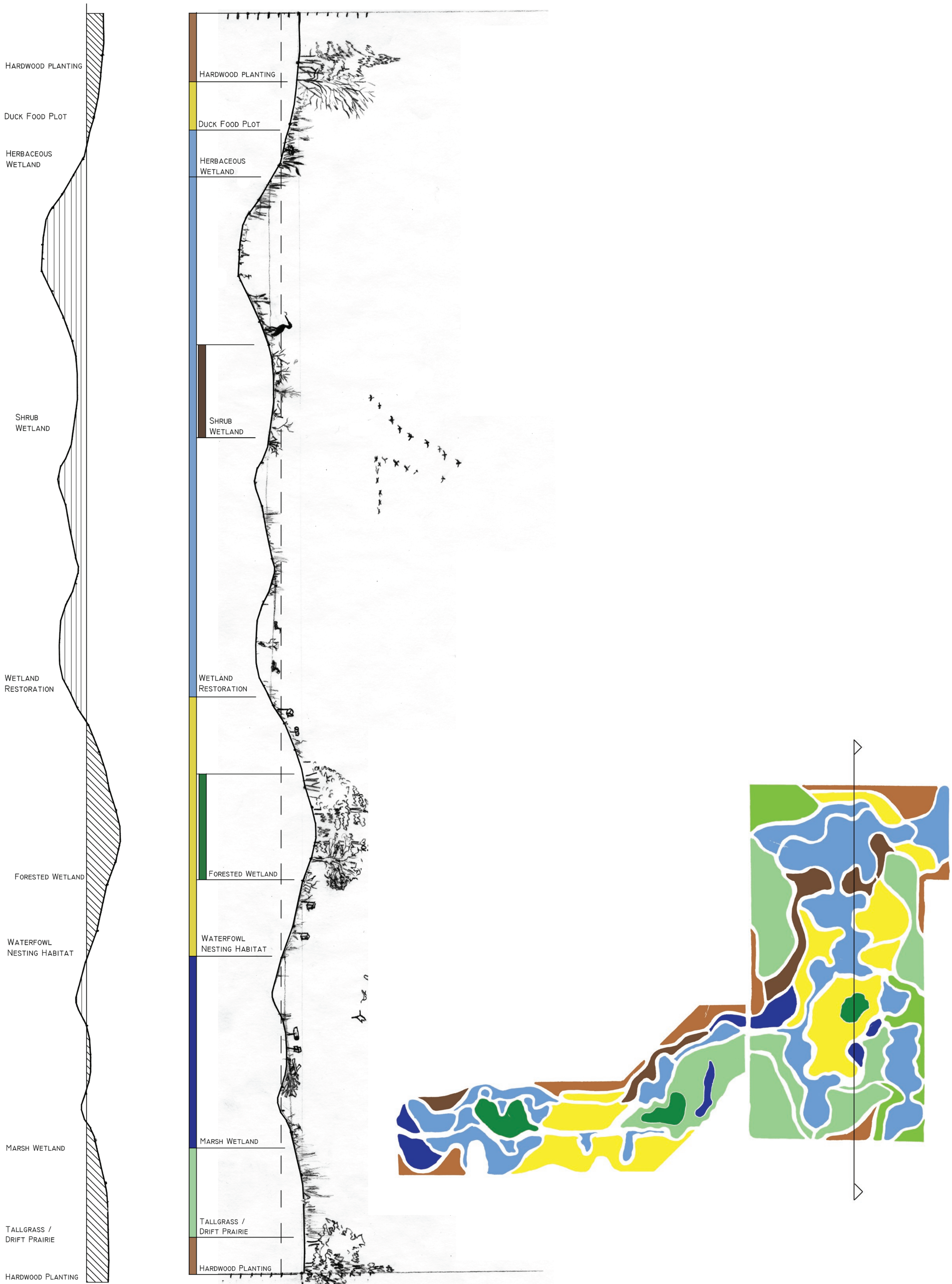
  Feeding and resting areas for migrating waterfowl and shorebirds and stream flow maintenance for downstream fish habitat.

Refuge wetlands, prairies, grasslands, and stream corridors provide wildlife with diverse habitats that can sustain them in all times all the year. Birds commonly associated with Eastern woodlands as well as birds common in Midwestern grasslands are found here. During the course of a year, over 243 different bird species use refuge habitats.

Wetlands on the refuge come in a variety of sizes and depths. Temporary and seasonal wetlands fill with water in the early spring from snowmelt and are usually dry by mid-summer. These smaller wetlands provide important food resources for migrating birds and pair as habitat for breeding ducks







Hardwood planting
Duck Food Plot
Herbaceous Wetland
Shrub Wetland
Wetland Restoration
Forested Wetland
Waterfowl Nesting Habitat
Marsh Wetland
Tallgrass / Drift Prairie
Hardwood Planting

CP2 Mix: Permanent Native Grasses

Seeding Rate: 8.28 Lbs./Acre (33.8 Seeds/Ft2)

SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/Ft2	Rate/Acre
GRASSES:				
Andropogon gerardii	Big Bluestem	42.26%	12.9	3.50 PLS Lbs
Bouteloua curtipendula	Sideoats Grama	12.08%	2.2	1.00 PLS Lbs
Sorghastrum nutans	Indiangrass	42.26%	15.4	3.50 PLS Lbs
WILDFLOWERS:				
Astragalus canadensis	Canada Milk Vetch	0.38%	0.2	0.50 PLS Oz
Dalea candidum	White Prairie Clover	0.68%	0.4	0.90 PLS Oz
Dalea purpurea	Purple Prairie Clover	0.75%	0.3	1.00 PLS Oz
Monarda fistulosa	Wild Bergamot	0.30%	0.6	0.40 PLS Oz
Ratibida pinnata	Yellow Coneflower	0.53%	0.5	0.70 PLS Oz
Rudbeckia hirta	Black-eyed Susan	0.23%	0.6	0.30 PLS Oz
Solidago rigida	Stiff Goldenrod	0.53%	0.7	0.70 PLS Oz

BWSR Native Wet Prairie

Seeding Rate: 5.5 Lbs./Acre (44.4 Seeds/Ft2)

SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/Ft2	Rate/Acre
GRASSES:				
Andropogon gerardii	Big Bluestem	21.82%	3.6	1.20 PLS Lbs
Carex vulpinoidea	Brown Fox Sedge	0.91%	1.5	0.05 PLS Lbs

Elymus virginicus	Virginia Wild Rye	36.36%	3.4	2.00 PLS Lbs
Panicum virgatum	Switchgrass	3.64%	1.8	0.20 PLS Lbs
Scirpus atrovirens	Green Bulrush	1.82%	16.9	0.10 PLS Lbs
Scirpus validus	Softstem Bulrush	0.91%	0.6	0.05 PLS Lbs
Sorghastrum nutans	Indiangrass	18.18%	3.9	1.00 PLS Lbs
Spartina pectinata	Prairie Cord Grass	7.27%	1.0	0.40 PLS Lbs

WILDFLOWERS:

Asclepias incarnata	Swamp Milkweed	1.14%	0.1	1.00 PLS Oz
Aster novae-angliae	New England Aster	0.23%	0.4	0.20 PLS Oz
Eupatorium perfoliatum	Boneset	0.23%	0.7	0.20 PLS Oz
Helenium autumnale	Sneezeweed	0.57%	1.1	0.50 PLS Oz
Liatris pycnostachya	Prairie Blazingstar	1.14%	0.2	1.00 PLS Oz
Lobelia siphilitica	Great Blue Lobelia	0.23%	2.1	0.20 PLS Oz
Pycnanthemum virginianum	Mountain Mint	0.23%	0.5	0.20 PLS Oz
Rudbeckia hirta	Black-eyed Susan	1.14%	2.2	1.00 PLS Oz
Verbena hastata	Blue Vervain	1.70%	0.2	1.50 PLS Oz
Vernonia fasciculata	Common Ironweed	1.14%	0.6	1.00 PLS Oz
Veronicastrum virginicum	Culver's Root	0.23%	3.4	0.20 PLS Oz
Zizia aurea	Golden Alexanders	1.14%	0.3	1.00 PLS Oz

BWSR Native Emergent / Wetland Buffer

Seeding Rate: 5 Lbs./Acre (113.5 Seeds/Ft2)

SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/Ft2	Rate/Acre
GRASSES:				
Beckmannia syzigachne	American Sloughgrass	20.00%	18.4	1.00 PLS Lbs
Glyceria canadensis	Rattlesnake Grass	2.40%	3.3	0.12 PLS Lbs
Glyceria grandis	Reed Manna Grass	7.00%	9.0	0.35 PLS Lbs
Leersia oryzoides	Rice Cut Grass	6.00%	3.7	0.30 PLS Lbs
SEDGES & RUSHES:				
Carex comosa	Bottlebrush Sedge	6.00%	3.3	0.30 PLS Lbs
Carex hystricina	Porcupine Sedge	6.00%	3.3	0.30 PLS Lbs
Carex lacustris	Lake Sedge	1.00%	0.2	0.05 PLS Lbs
Carex stricta	Tussock Sedge	1.00%	1.0	0.05 PLS Lbs
Carex vulpinoidea	Brown Fox Sedge	8.00%	14.7	0.40 PLS Lbs
Eleocharis acicularis	Spike Rush	3.00%	3.9	0.15 PLS Lbs
Eleocharis palustris	Great Spike Rush	3.00%	2.8	0.15 PLS Lbs
Juncus effusus	Common Rush	1.60%	29.4	0.08 PLS Lbs
Scirpus fluviatilis	River Bulrush	3.20%	0.3	0.16 PLS Lbs
Scirpus validus	Softstem Bulrush	3.20%	1.8	0.16 PLS Lbs
Sparganium eurycarpum	Giant Bur Reed	4.00%	0.0	0.20 PLS Lbs
WILDFLOWERS:				
Acorus calamus	Sweet Flag	3.20%	0.4	0.16 PLS Lbs
Alisma triviale	Water Plantain	8.00%	9.7	0.40 PLS Lbs
Asclepias incarnata	Swamp Milkweed	6.40%	0.6	0.32 PLS Lbs
Sagittaria latifolia	Common Arrowhead	7.00%	7.8	0.35 PLS Lbs

Native Mesic Tall Grass Prairie

Seeding Rate: 15 Lbs./Acre (47.3 Seeds/Ft2)

SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/Ft2	Rate/Acre
GRASSES:				
Agropyron smithii	Western Wheatgrass	5.30%	2.0	0.80 PLS Lbs
Agropyron trachycaulum	Slender Wheatgrass	5.30%	2.0	0.80 PLS Lbs
Andropogon gerardii	Big Bluestem	9.30%	5.1	1.40 PLS Lbs
Avena sativa	Oats	32.00%	2.1	4.80 PLS Lbs
Bouteloua curtipendula	Sideoats Grama	7.30%	2.4	1.10 PLS Lbs
Elymus canadensis	Canada Wild Rye	6.00%	1.7	0.90 PLS Lbs
Panicum virgatum	Switchgrass	4.70%	3.6	0.71 PLS Lbs
Schizachyrium scoparium	Little Bluestem	10.00%	8.3	1.50 PLS Lbs
Sorghastrum nutans	Indiangrass	9.30%	6.1	1.40 PLS Lbs
Stipa virdula	Green Needle Grass	4.00%	1.7	0.60 PLS Lbs
WILDFLOWERS:				
Allium stellatum	Prairie Onion	0.20%	0.1	0.03 PLS Lbs
Aster ericoides	Heath Aster	0.30%	3.3	0.05 PLS Lbs
Aster laevis	Smooth Blue Aster	0.20%	0.6	0.03 PLS Lbs
Astragalus canadensis	Canada Milk Vetch	0.30%	0.3	0.05 PLS Lbs
Dalea candidum	White Prairie Clover	0.20%	0.2	0.03 PLS Lbs
Dalea purpurea	Purple Prairie Clover	0.40%	0.3	0.06 PLS Lbs
Desmodium canadense	Showy Tick Trefoil	1.40%	0.4	0.21 PLS Lbs
Heliopsis helianthoides	Ox-eye Sunflower	0.40%	0.1	0.06 PLS Lbs
Monarda fistulosa	Wild Bergamot	0.40%	1.5	0.06 PLS Lbs

Penstemon grandiflorus	Large-flowered Beardtongue	0.10%	0.1	0.02 PLS Lbs
Ratibida columnifera	Long-headed Coneflower	0.20%	0.5	0.03 PLS Lbs
Rudbeckia hirta	Black-eyed Susan	0.30%	1.5	0.05 PLS Lbs
Solidago rigida	Stiff Goldenrod	0.50%	1.1	0.08 PLS Lbs
Verbena hastata	Blue Vervain	0.20%	1.0	0.03 PLS Lbs
Zizia aurea	Golden Alexanders	1.70%	1.0	0.26 PLS Lbs

Native Floodplain & Wetland

Seeding Rate: 6 Lbs./Acre (180.7 Seeds/Ft2)

SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/Ft2	Rate/Acre
GRASSES:				
Beckmannia syzigachne	American Sloughgrass	25.00%	27.5	1.50 PLS Lbs
Calamagrostis canadensis	Blue Joint Grass	1.00%	6.2	0.06 PLS Lbs
Glyceria grandis	Reed Manna Grass	3.00%	4.6	0.18 PLS Lbs
Glyceria striata	Fowl Manna Grass	2.00%	4.0	0.12 PLS Lbs
Leersia oryzoides	Rice Cut Grass	4.00%	3.0	0.24 PLS Lbs
Lolium italicum	Annual Rye	15.00%	5.0	0.90 PLS Lbs
Poa palustris	Fowl Bluegrass	30.00%	86.0	1.80 PLS Lbs
SEDGES & RUSHES:				
Carex stricta	Tussock Sedge	1.00%	1.2	0.06 PLS Lbs
Carex vulpinoidea	Brown Fox Sedge	5.00%	11.0	0.30 PLS Lbs
Scirpus atrovirens	Green Bulrush	1.00%	10.1	0.06 PLS Lbs
Scirpus cyperinus	Woolgrass	0.10%	3.7	0.01 PLS Lbs
Scirpus fluviatilis	River Bulrush	4.00%	0.4	0.24 PLS Lbs
Scirpus validus	Softstem Bulrush	2.00%	1.4	0.12 PLS Lbs

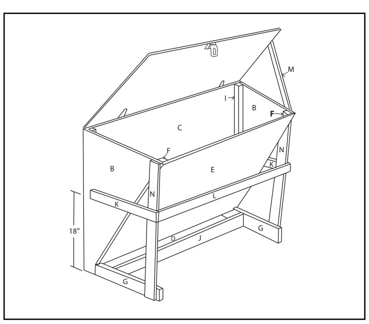
WILDFLOWERS:

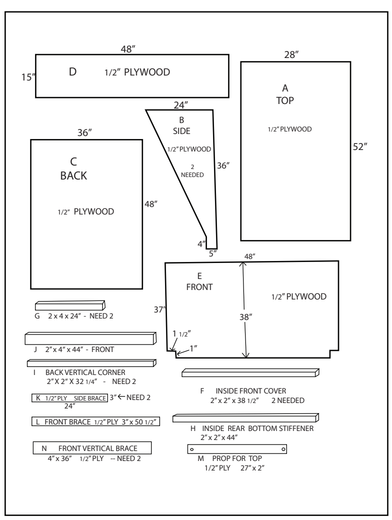
Asclepias incarnata	Swamp Milkweed	2.00%	0.2	0.12 PLS Lbs
Aster umbellatus	Flat-topped Aster	0.50%	0.7	0.03 PLS Lbs
Eupatorium maculatum	Joe Pye Weed	0.50%	1.0	0.03 PLS Lbs
Eupatorium perfoliatum	Boneset	0.40%	1.4	0.02 PLS Lbs
Helenium autumnale	Sneezeweed	0.40%	1.1	0.02 PLS Lbs
Impatiens capensis	Spotted Touch-me-not	1.00%	0.1	0.06 PLS Lbs
Lobelia siphilitica	Great Blue Lobelia	0.20%	2.2	0.01 PLS Lbs
Mimulus ringens	Monkey Flower	0.10%	5.1	0.01 PLS Lbs
Pycnanthemum virginianum	Mountain Mint	0.20%	1.0	0.01 PLS Lbs
Solidago gigantea	Giant Goldenrod	0.40%	2.2	0.02 PLS Lbs
Verbena hastata	Blue Vervain	0.60%	1.2	0.04 PLS Lbs
Vernonia fasciculata	Common Ironweed	0.60%	0.3	0.04 PLS Lbs

Pheasant Feeder

Pheasant Feeder Materials Needed:

- 2 Sheets of 1/2” exterior plywood
- 2 and a half 8’ 2 x 4 studs
- 2 Hinges, bolts foe the hardware, nail, and sealant if necessary





Example of integrated feeding grounds within protective Riparian habitat. The feeders provide valuable food supplies throughout the year while aesthetically hidden by the ground cover.

Riparian Hardwoods

Despite North Dakota’s characterization as a prairie state, native forests are an extremely valuable resource due to their limited size and distribution. Riparian forests and upland deciduous forests constitute the majority of North Dakota’s forest resources. In addition, conservation plantings such as windbreaks and living snow fences contribute substantial wooded acreage. Deciduous forests along riparian corridors in the eastern half of the state represent the majority of North Dakota’s forests. Dominant species mirror that of any proposed hardwood stands or tree rows with encouragement of a greater percentage of species in the upper tropic structure of water consuming hardwoods, meaning Salix species and/or Birch and Poplar species.

Hardwood Tree plantings / Wind breaks

Green ash (Fraxinus pennsylvannica),
Box elder (Acer negundo) and
American elm (Ulmus americana).
Ponderosa pine (Pinus ponderosa) and
Rocky mountain juniper (Juniperus scopulorum)
Aspen (Populus tremuloides)
Bur oak (Quercus macrocarpa)
Cottonwood (Populus deltoides)

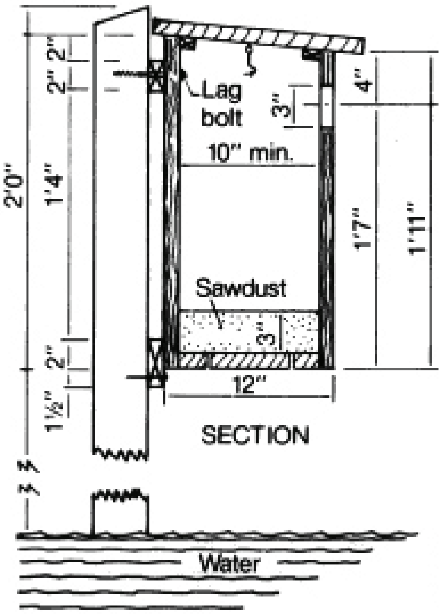
Shrub Wetland

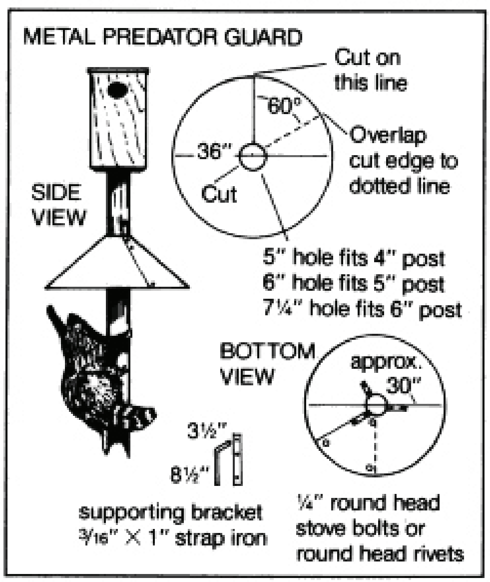
Shrub Species

Speckled Alder	Alnus incana
Smoothe Alder	A. serrulata
Highbush Blueberry	Vaccinium corymbosum
Meadowsweet	Spirea alba var. latifolia
Hardhack	S. tomentosa
button Bush	Cephalanthus occidentalis
Maleberry	Lyonia ligustrina
Swamp azalea	Rhododendron viscosum
Silky Dogwood	Cornus amomum
Winter Berry	Ilex verticillata
Sweet Gale	Myrica gale
Elderberry	Sanguisorba canadensis
Pussy Willow	Salix discolo
Black Willow	S. nigra
Silky Willow	S. sericea
Sageleaf Willow	S. candida
Autumn Willow	S. serissima
Arrowood Viburnum	Viburnum dentatum

Tree Species

Red Maple	Acer rubrum
Gray Birch	Betula poulifolia
Yellow Birch	B. allegheniensis
White Pine	Pinus strobis
Larch	Larix laricina
Eastern Hemlock	Tsuga canadensis
Red Spruce	Picea rubens
Black Spruce	P. mariana





Waterfowl Mix For Food Plots

Contains a mixture of Japanese Millet, White Proso Millet, Buckwheat, Penngrain. DR Grain Sorghum. Matures in 60-90 days.

50% - Japanese Millet
25% - White Proso Millet
10% - Buckwheat
10% - Sorghum

SEED RATE: Plant at the rate of 1lb. per 1000 sq. ft. or 25-50 lb. per acre
Matures - 60-90 days
Broadcast rates are higher than drilled. Depth for drilling: ¼"

Plant Food Plot Seed design for near water sources that attract migratory birds. Planting lie along lakes, beaver ponds and swamp areas inhabited by ducks or used by ducks during their migratory season. Best planted in sites that are prone to seasonal flooding or can be flooded manually when plants have matured. Seeds have hard coats and will not mold in the wet sites and should be left undisturbed to germinate and will mature in 60 - 90 days. This mix can be planted early spring or early fall. Regular yearly plantings are best to create a habitat feeding pattern and help insure the yearly health of the returning waterfowl

Deer Country Field Mix

This Field Mix was developed to provide excellent forage feed for deer in the spring, summer, and fall. This mixture was designed to perform well under a wide range of growing and soil conditions in the Upper Midwest. It can be planted in areas ranging from full sun to semi-shade and is an excellent choice for plot areas along wood lines or open spots in the woods.

20% Alsike Clover
20% Ladino Clover
15% Rape Seed
20% Medium Red Clover
10% White Dutch Clover
15% Boost Perennial Ryegrass

Seeding Rate: 10 Lbs./Acre Drilled; 15-20 Lbs./Acre Broadcast (packaged in 25-lb. Bags)

Plant Materials for Salt-Affected Sites in the Northern Great Plains

Both CRP saline land practices CP18B and CP18C are intended to improve soil quality and plant productivity on unproductive cropland by planting suitable perennial vegetation and maintaining it for a 10-year contract period. Vigorous, perennial vegetation will utilize soil moisture and reduce excess salt accumulation in the root zone associated with excess groundwater. These practices are intended to reduce or reverse the harmful movement and accumulation of salt due to management or farming practices.

The soil must have an electrical conductivity of four decisiemens per meter or higher at 250 Celsius.
Saline seep discharge areas occur where salts accumulate within 18 inches of the soil surface.
Seeding into surface residue or applying mulch after the seeding operation will reduce evaporation from the soil surface and protect emerging seedlings.
Tree and shrub species are generally not recommended for planting on salt-affected sites. However, some species are considered moderately tolerant

** Older bare-root stock and/or potted stock are recommended for planting rather than small seedlings because of the greater salt tolerance of larger plants.

** Russian olive and Siberian elm, which are rated moderately tolerant, are generally not recommended because they can become invasive.

Herbaceous plants

Tolerant (EC 15-25)

*Beardless Wildrye
Tall Wheatgrass
Russian Wildrye
*Hybrid Wheatgrass
Slender Wheatgrass
Altai Wildrye
*Tall Fescue
*Western Wheatgrass
*Strawberry Clover

Moderately Tolerant (EC 10-15)

Crested Wheatgrass
Thickspike Wheatgrass
Intermediate Wheatgrass
Pubescent Wheatgrass
*Creeping Foxtail
*Prairie Cordgrass
Canada Wildrye
Buffalograss

Trees and Shrubs

Moderatly tolerant (EC 8-15)

Seaberry
Silverberry
Fourwing Saltbush
Silver Buffaloberry
Golden Currant
Hawthorn
Caragana
Green Ash
Rocky Mountain Juniper
Common Lilac
Ponderosa Pine
Skunkbush Sumac
Austrian Pine

forbs and legumes.

Moderately Sensitive (EC 2-6)

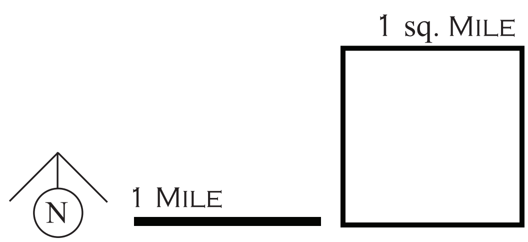
Blanket Flower
Yarrow
Yellow Coneflower
Fringed sagewort
Purple Prairie Clover
Primrose
Stiff Sunflower
Maximilian Sunflower
Lewis Flax
Canada Milkvetch
Two-grooved Milkvetch
Scarlet Globemallow

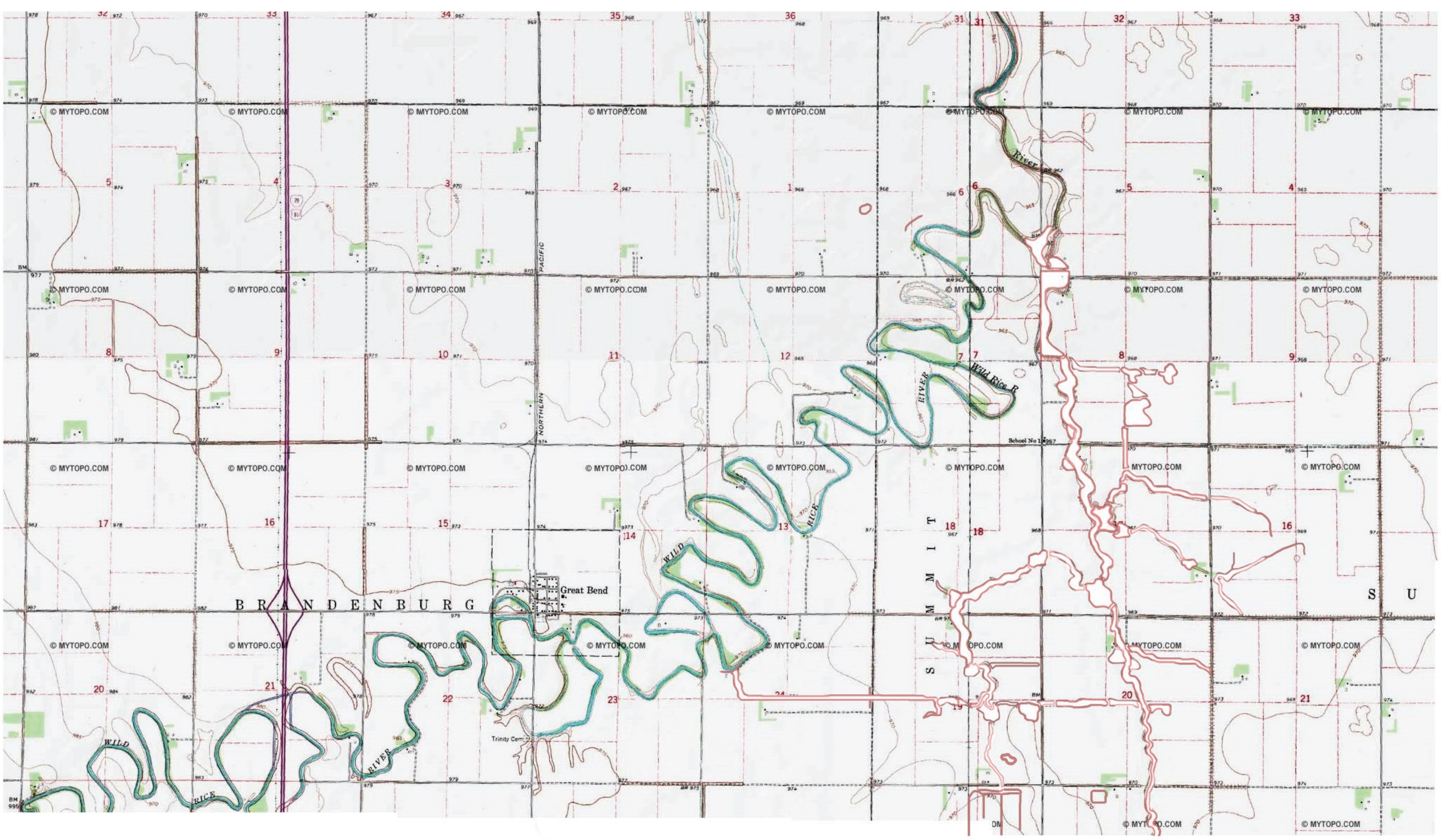
* Indicates a preference to wet conditions

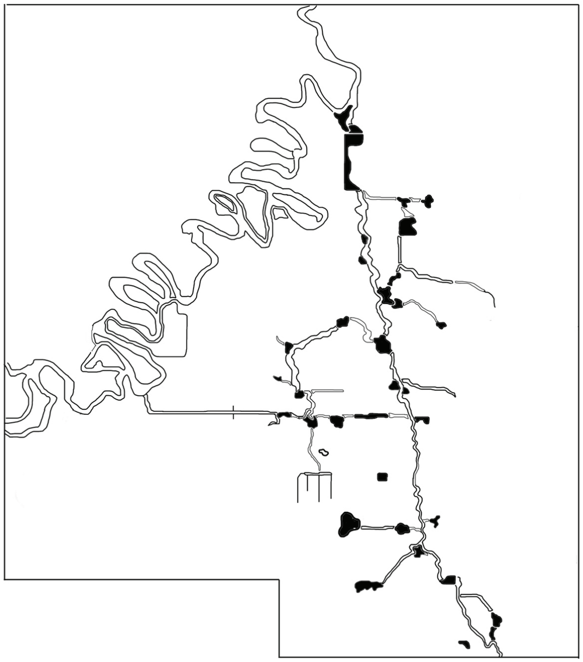
Great bend Cooperative saline System

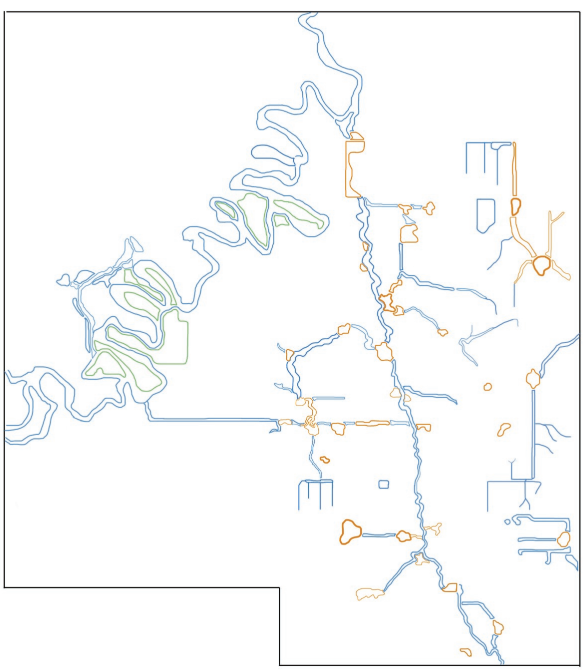
Off stream retention / Saline habitat and vegetation /Hydrological Saline Soil treatment

Existing salinity problems located around Brandenburg township within Richland County are caused by a number of cumulative problems resulting in the accumulation of soluble salts in the root zone. These excess salts reduce plant growth and vigor by altering water uptake and causing ion-specific toxicities or imbalances. These salts originate from the natural weathering of minerals or from fossil salt deposits left from ancient sea beds. Salts accumulate in the soil of arid climates as irrigation water or groundwater seepage evaporates, leaving minerals behind. Saline soils cannot be reclaimed by chemical amendments, conditioners or fertilizers, a field can only be reclaimed by removing salts from the plant root zone. This design looks to utilize off channel retention and hydrological percolation to force salts below root zones by means of vertical and horizontal water movement. Ecologically this area now becomes a designated and accepted saline habitat that can sustain itself in a unique environment while still contributing to the resilience of the areas dependent flora and fauna.









Case Study:

Feeding Ecology of Breeding Gadwalls on Saline Wetlands

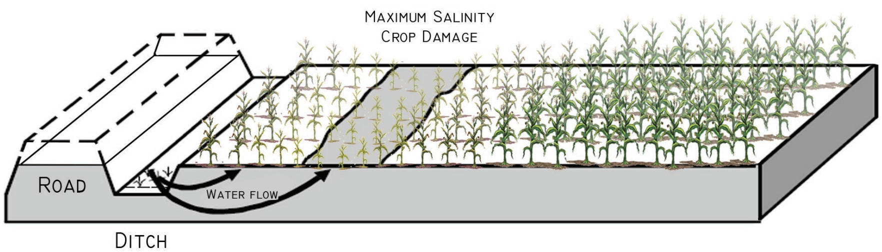
Jerome R. Serie and George A. Swanson
The Journal of Wildlife Management, Vol. 40, No. 1 (Jan., 1976), pp. 69-81 Published by: Allen Press
Stable URL: http://www.jstor.org/stable/3800157

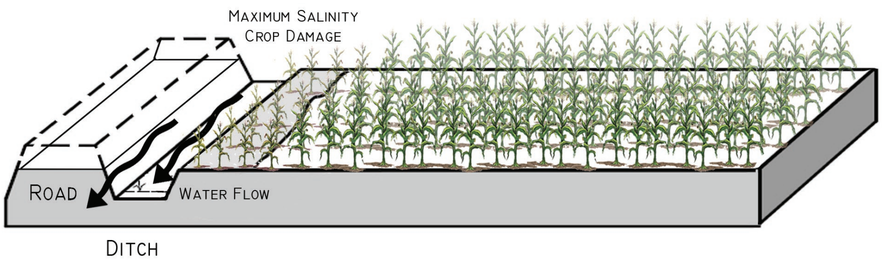
The feeding ecology of breeding gadwalls (Anas strepera) from saline wetlands in North Dakota was examined in relation to sex, pair mates, reproductive status, food availability, and wetland type. The data shows that the intake of important proteins needed for reproduction and secondary growth by egg laying female can be best sustained by the consumption of specific invertebrates found dominantly in saline environments. Conclusively, creating a functional saline environment serves to not only improve crop productivity in the surrounding subbasin but also serves as a sustainable habitat for regional duck species who feed on the endemic organisms for their much need nutrition.

Saline soils that have developed around lagoons and drainage ditches are by the water source. Salinity along drainage ditches is due to lateral movement of water from the ditches to adjacent fields.

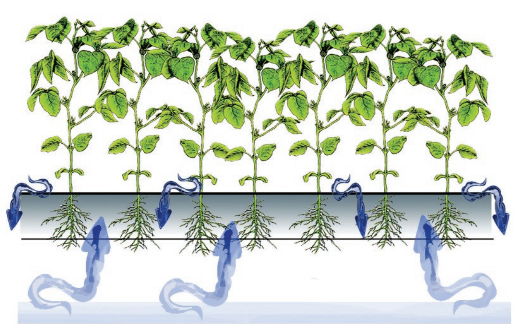
Extremely flat areas, such as the Red River Valley, are particularly susceptible to this type of secondary salinization. The low grade on most drainage ditches allows water to stand for long periods of time.

Under irrigated agriculture, secondary salinization may occur if water is not properly managed. All water from sources other than precipitation contains some dissolved salt. As irrigation water is used by crops, salts are precipitated in the soil. This process may eventually lead to saline conditions that plants cannot tolerate.

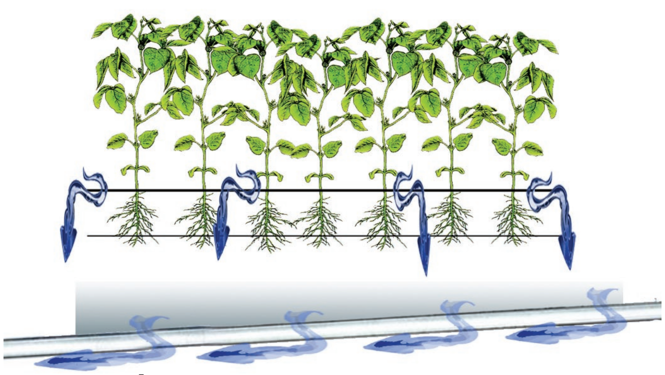




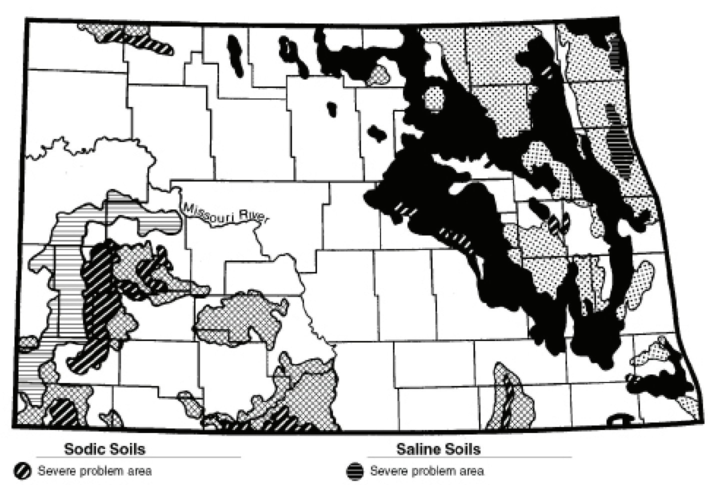
SURFACE SALTING AND CROP ENTRAPMENT



PLANT UPTAKE ACCUMULATION



SOLUTION: ARTIFICIAL DRAINAGE



SALINE LEVELS IN NORTH DAKOTA

DAMAGING LEVELS OF SALTS

** http://sis.agr.gc.ca/cansis/taxa/landscape/slc_prairie.html

Saline Soil management

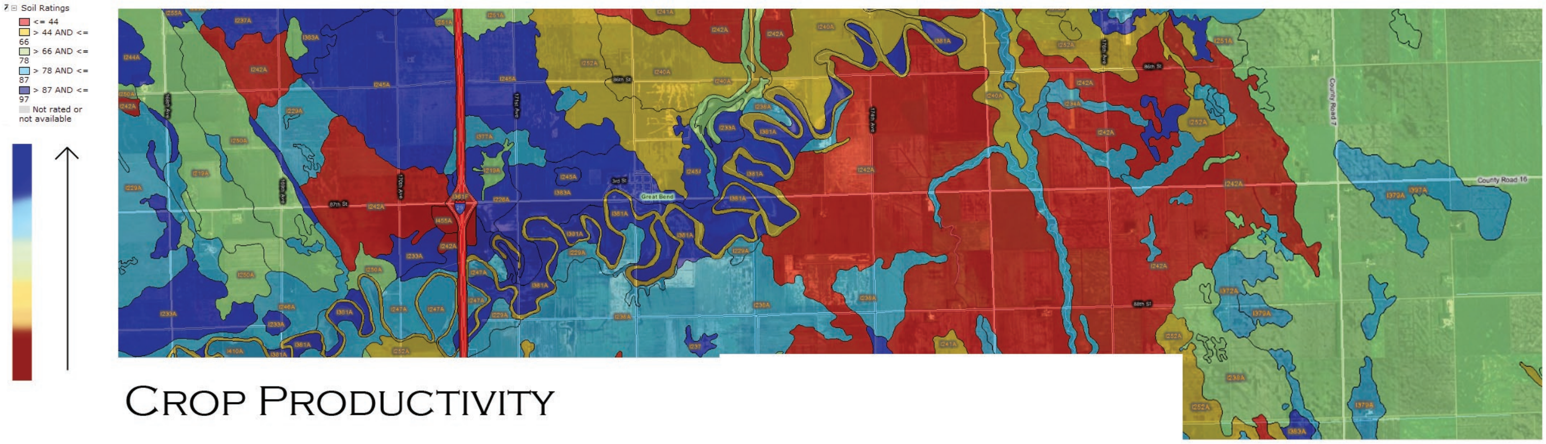
Management strategies for saline and sodic soils must be designed with processes of salt accumulation in mind. Different management techniques may be necessary for soils with different salt compositions and water regimes.

- Many cultivated crops are most susceptible to salinity during germination and early growth stages. If planting coincides with periods shortly after salts have been flushed from the surface, plant germination and seedling survival is more likely to be successful.

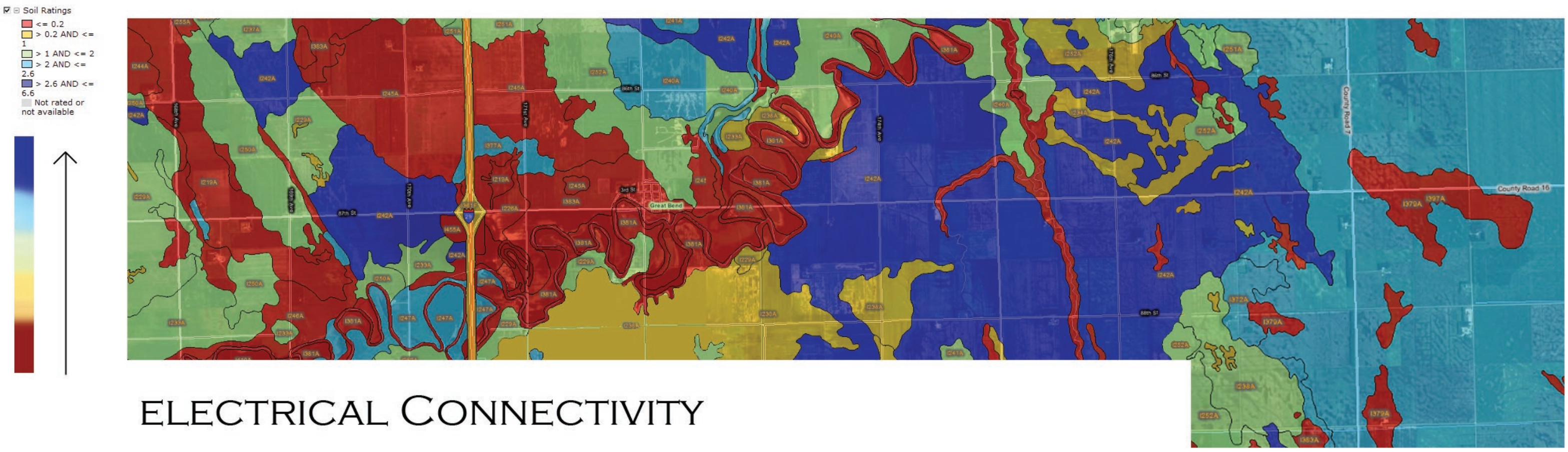
- Salt tolerant plant species should be selected on the basis of salt Concentrations found in saline areas. Drought resistant plants such as grasses and small grains are generally more tolerant to salinity than row crops, trees, shrubs, and vegetables

- Lateral movement of water to soils adjacent to road ditches can be reduced by preventing water from standing in the drainage ditches. Ditches should be designed and maintained to move water rapidly and minimize standing water. Lagoons should be designed to prevent leakage that causes salinization of adjacent soils.

- A specific water table may be controlled by reducing local groundwater recharge. Eliminating summer fallow in upland recharge positions is generally the most efficient method of controlling the water table in a saline seep.



Crop Productivity



electrical Connectivity

** USDA Soil Survey layers for *Crop Productivity* versus *Electrical connectivity* (Soil Salinity). You can see a direct relation to the presence of saline soil to loss in crop productivity based on biomass production of a given area. As salts go up, crop production goes down.

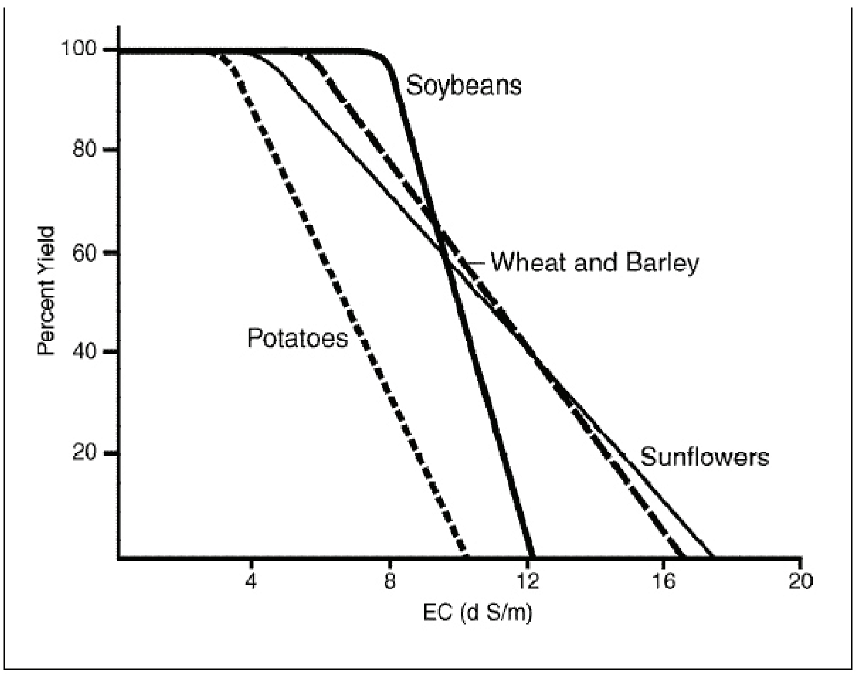


Figure 11. Thresholds of yield reduction due to salinity for some of the major crops in North Dakota. Salinity was expressed as the electrical conductivity (EC) of the saturated soil extract from the plow layer (0 to 6 inch depth). (After Maianu, 1983; 1984; and unpublished data; Maianu and Lukach, 1985; Nelson, unpublished data.)

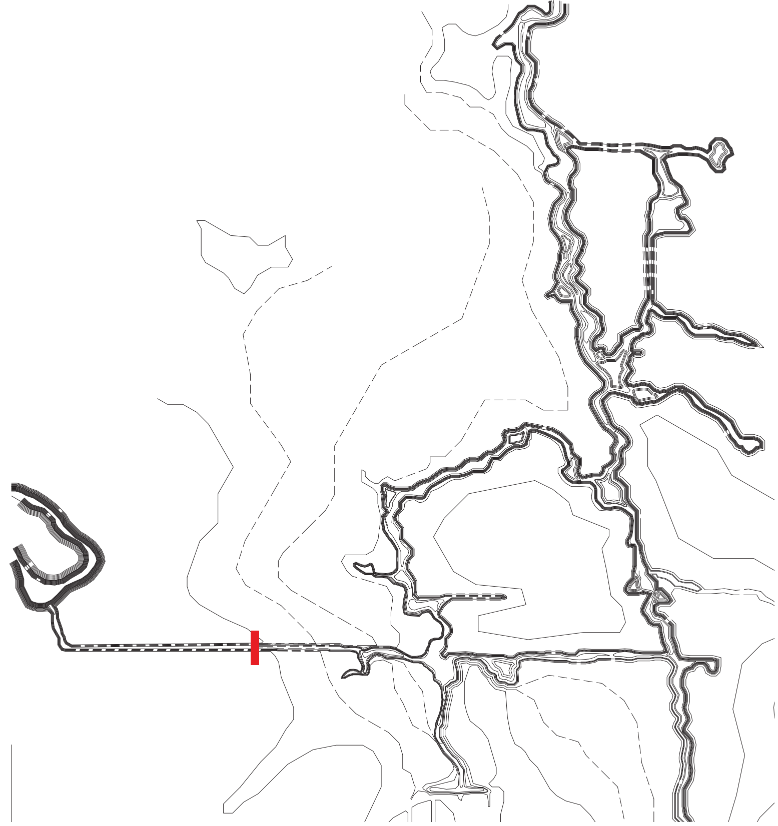
Saline levels Across Site: 4-5 dS/M

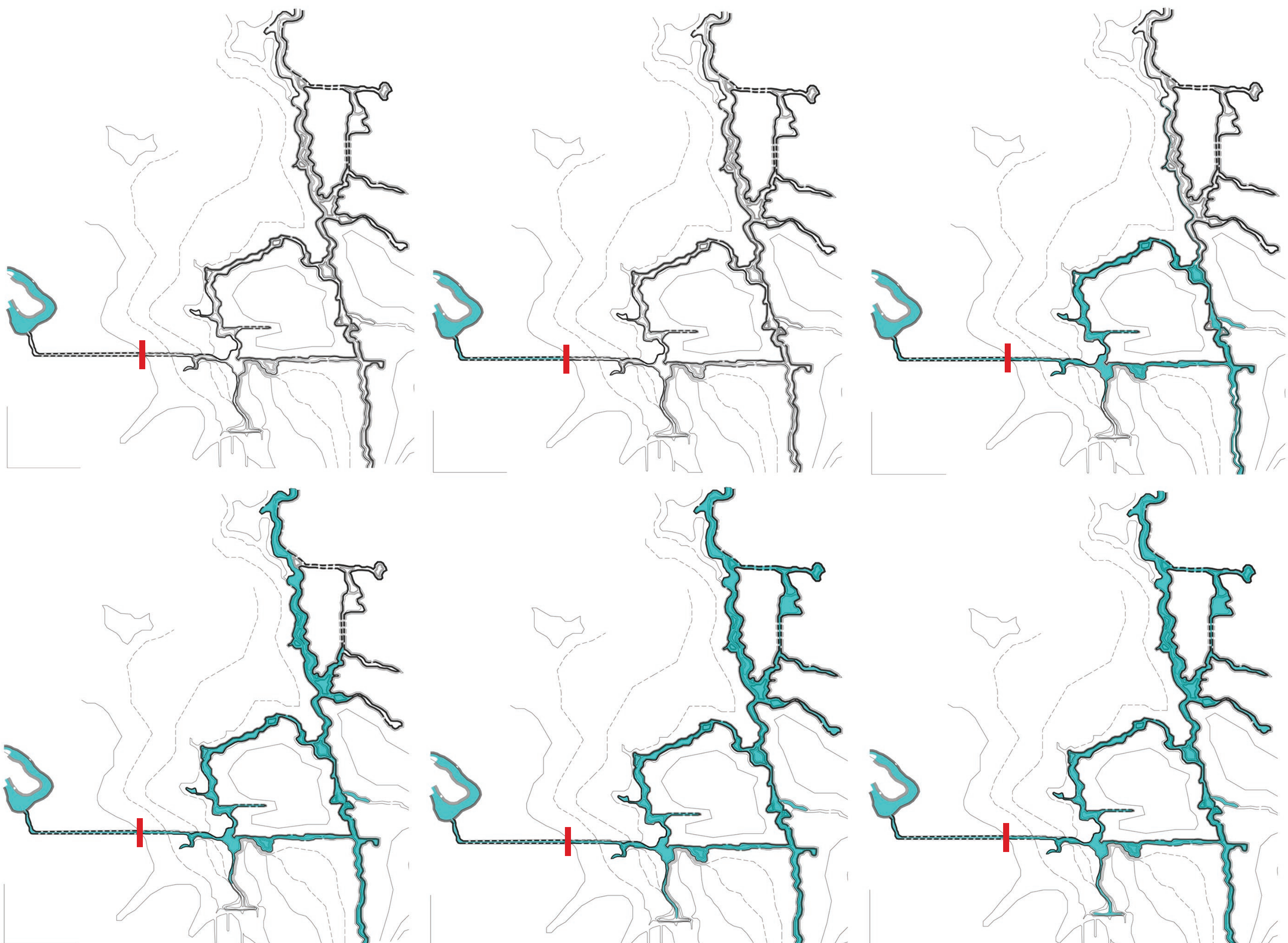
Yields of many crops are reduced noticeably when the soil extract EC reaches 4 dS/m (U.S. Salinity Laboratory Staff, 1954).

Yields will decline proportionately as EC levels (salinity) increase above 4 dS/m. Some crops, such as sugar beets, are quite tolerant to EC between 4 and 8 dS/m.

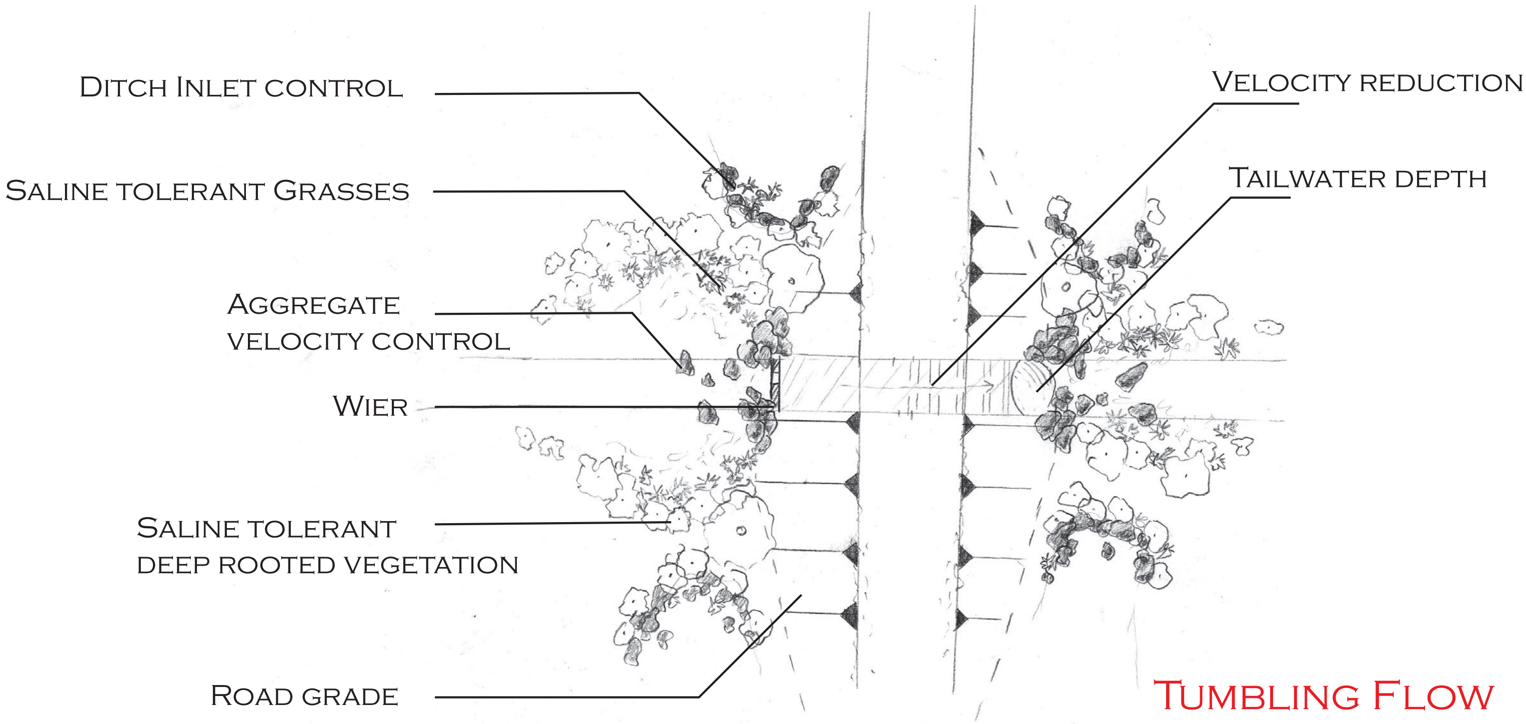
Percent Salt vs Amount of Water Reduction Required:

50% = 6 inches
80% = 12 inches
90% = 24 inches





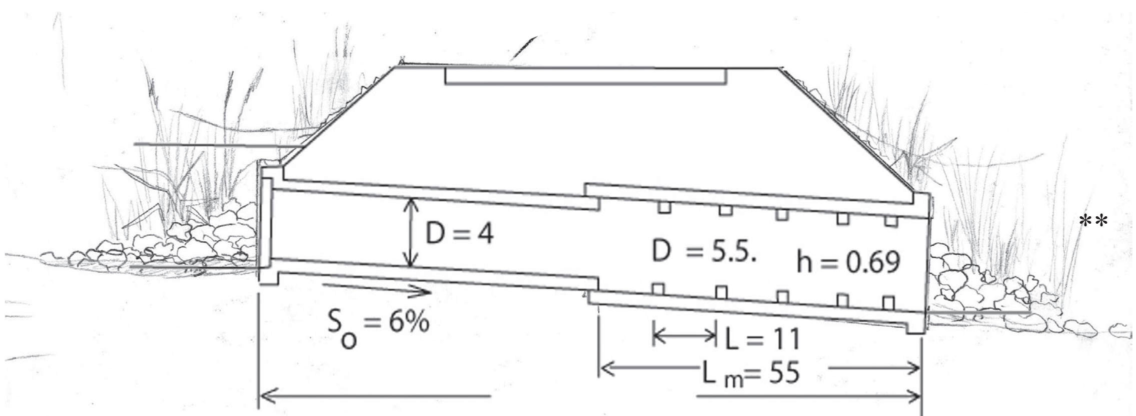
Inundation based on 1ft rises in Wild Rice Creek - open wier conditions



TUMBLING FLOW CULVERT

PLAN

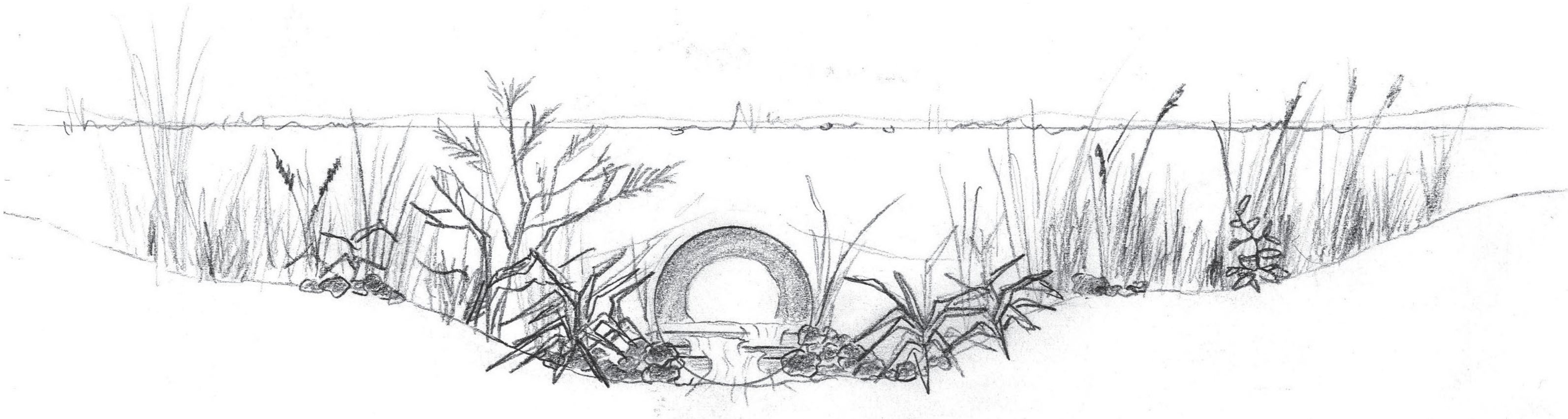
Q = 100 ft2 / S
D = 4.0 ft.
n = 0.013
S = 0.06 ft/ ft
TW = 2.5 ft



**

Q = discharge cfs)
S = culvert slope (ft/ft)
TW = tailwater depth (ft)

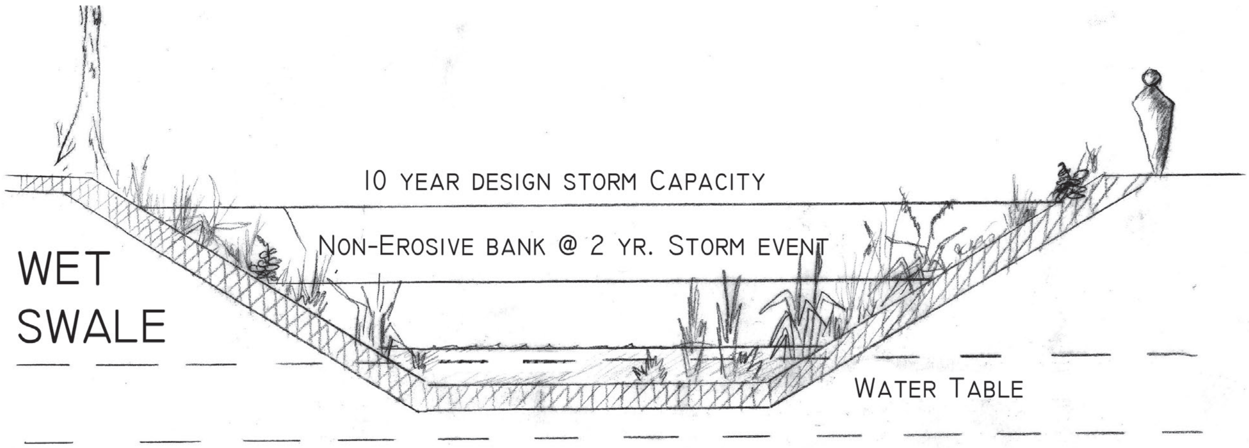
SECTION

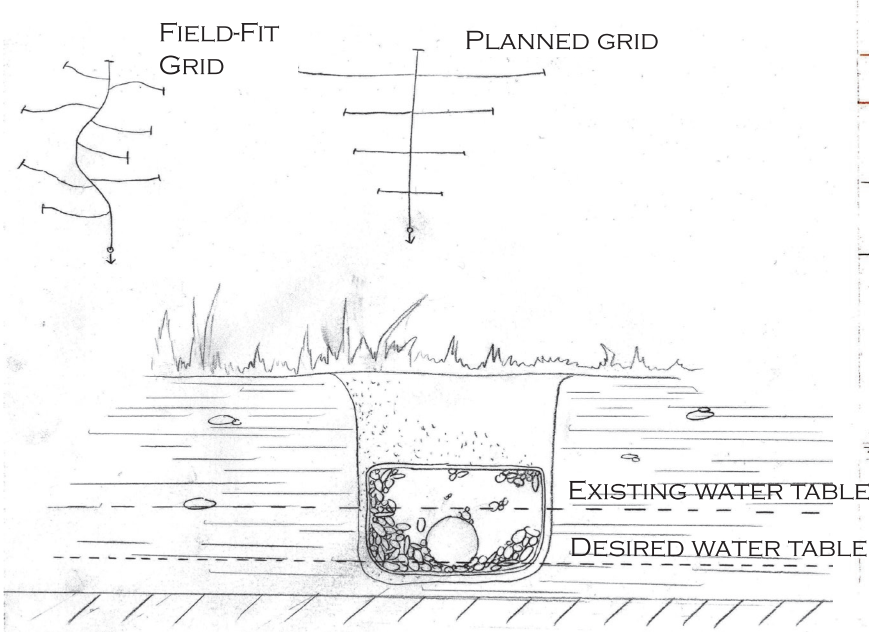


ELEVATION

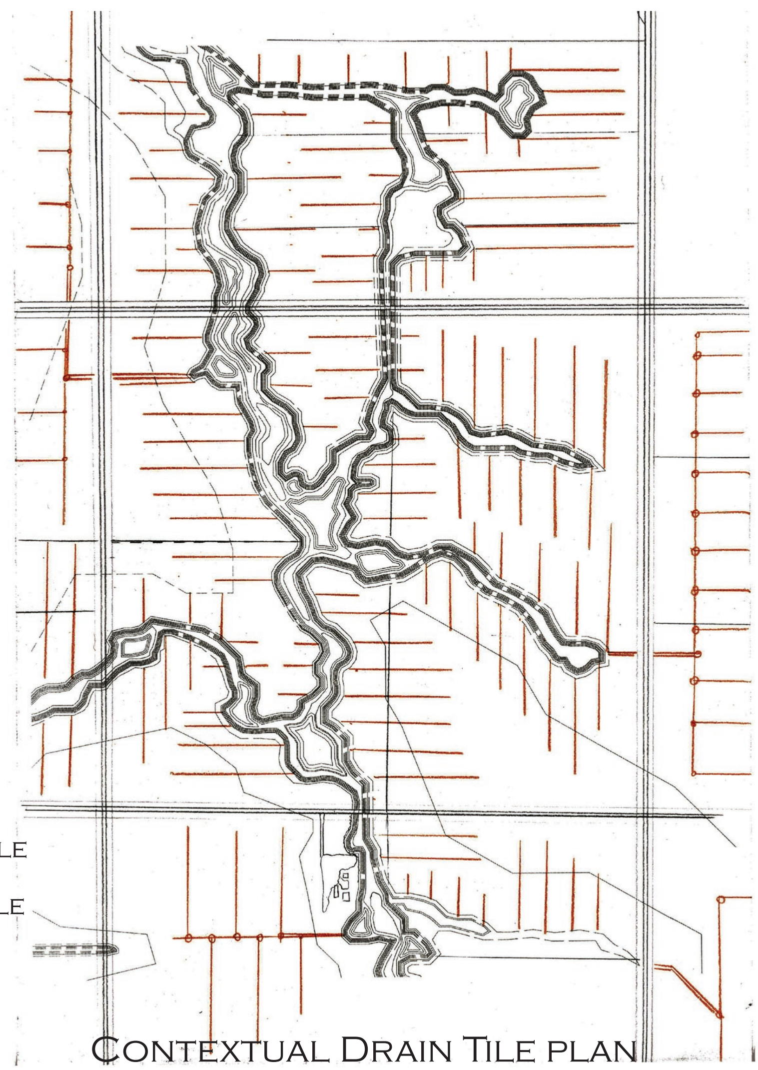
The system incorporates cut drainage ditches in fields below the water table level to channel away drainage water and allow the salts to leach out. Drainage tile or plastic drainpipe can also be buried in fields for this purpose.

The advantage of artificial drainage is that it provides the ability to use high quality, low salinity irrigation water (if available to a grower) to completely remove salts from the soil. With all artificial drainage systems you must also consider disposal of the drainage water. Restrictions on the discharge of drain water to streams may apply in certain situations, hence the need for absorption and percolation in the deeper retention ponds. Artificial drainage systems will not work where there is no saturated condition in the soil. Water will not collect in a drain if the soil around it is not saturated.





Drain Tile

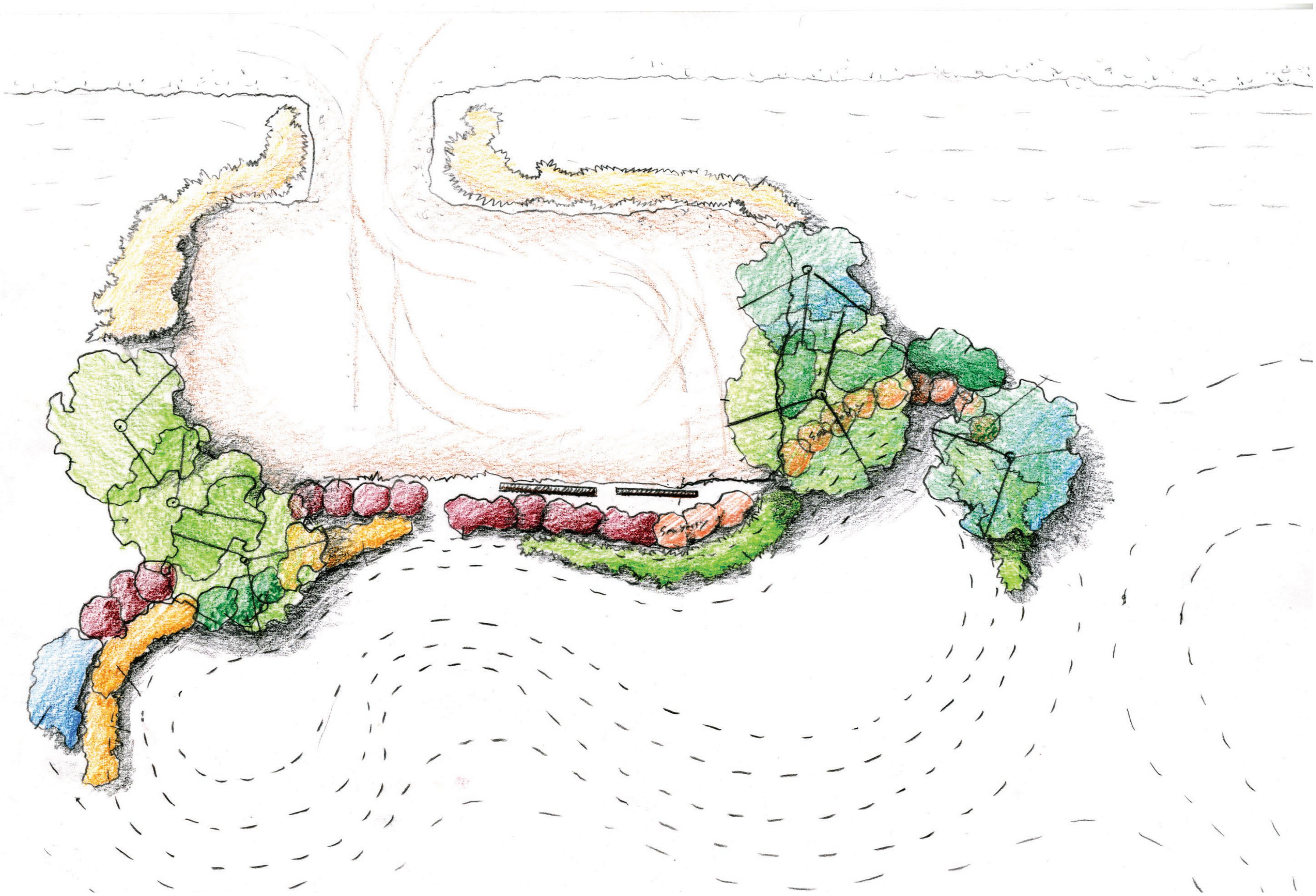


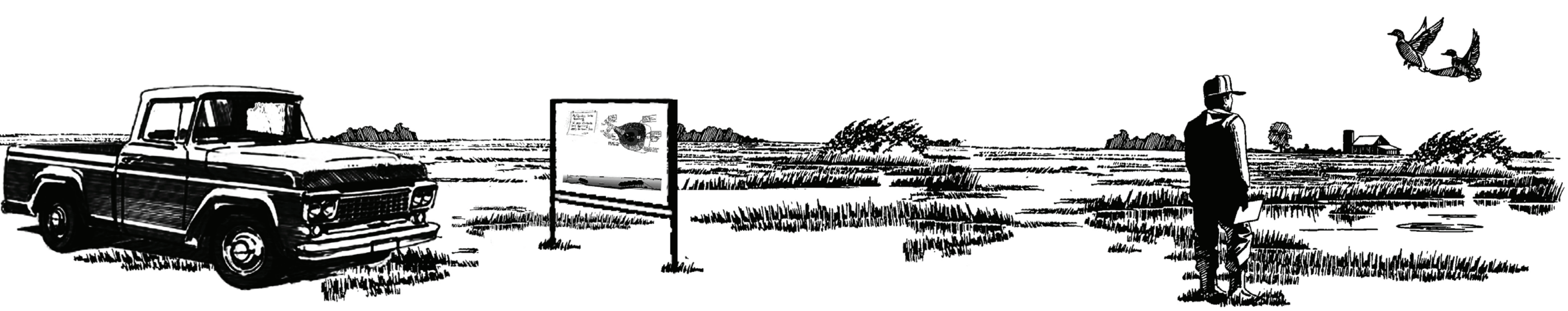
Contextual Drain Tile plan

Saline community Postings Board

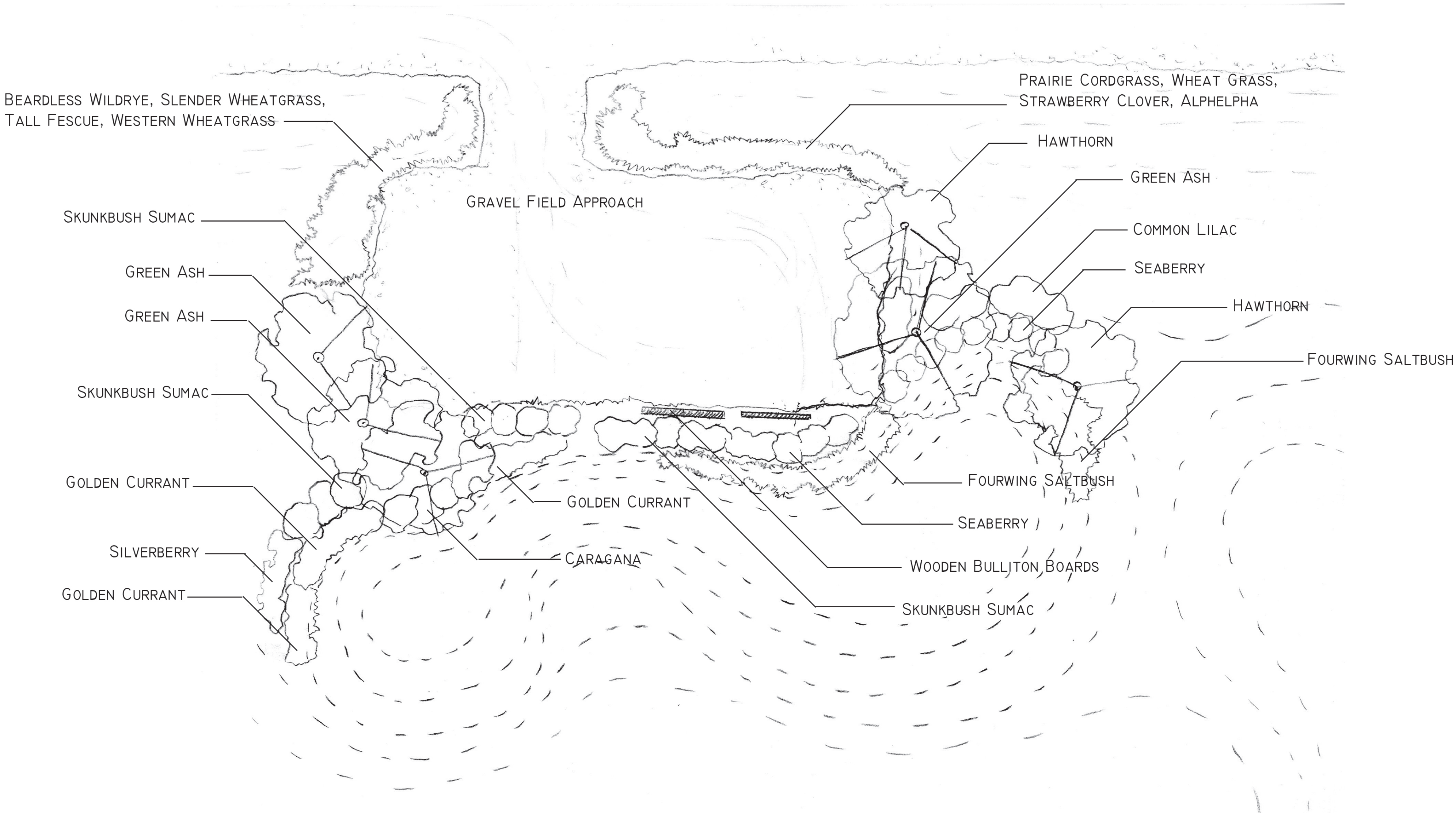
In order for a communal systems such as this to sustain itself in funcIn order for a communal systems such as this to sustain itself in function both ecologically and socially, it must also incorporate issues pertaining to social structures and sociological resilience.

To help to the progression and continued involvement of people around the saline environment the design includes a community posting node where land owners who are contributing to the systems can post anything from newsletters, financial opportunities, and management techniques to educational boards, new techniques being developed, and general thoughts and concerns about how the systems is running or progressing. The site is located in the central road crossing within the system and oversees a special designed and planted section of the saline environment to demonstrate planting options, species ideas, and general look of a well developed saline habitat.





Saline Environment



Pot Hole Consolidation

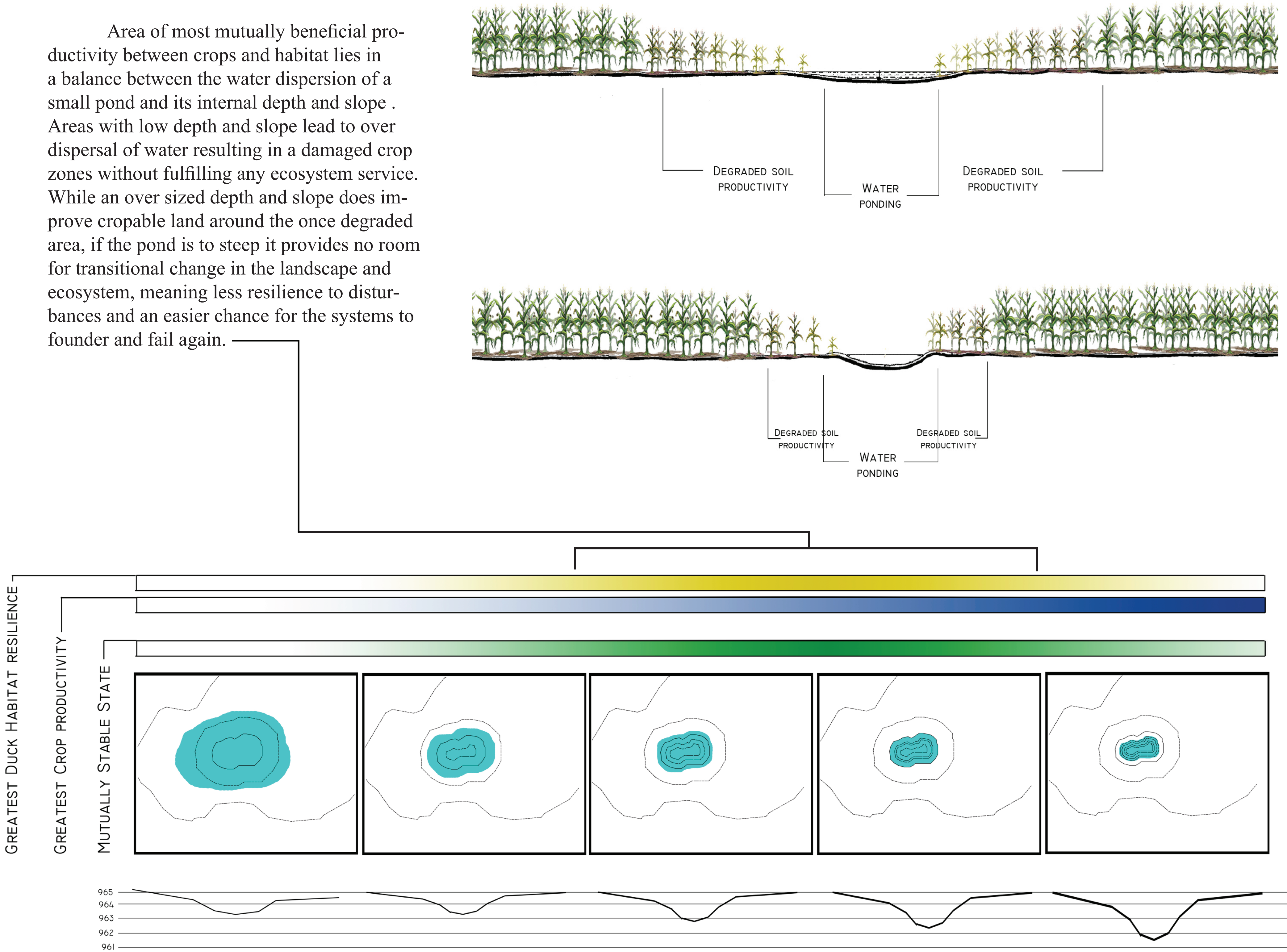
Run-Off retention/ wildlife habitat / Improved Crop Productivity

In the prairie potholes regions of South Dakota and North Dakota, the farming landscape is dotted with potholes that are either permanent of temporary potholes that provide important habitat for waterfowl. You can't drain potholes but in some years you can farm them if they dry out. And some potholes are now more like permanent lakes along the migratory flyways. When these ponds are in existence they have an immense effect on local wildlife systems and hydrological systems, yet due to the fact that many of these pothole ponds are not permanent and only result of occasional inundation, established flora and fauna species cannot rely on its continued contributions to the ecosystem. Also due to the fact that farmers are allowed to crop these areas when they do run dry, introduces a huge disturbance regime that may or may not coincide with natural temporal shifts.

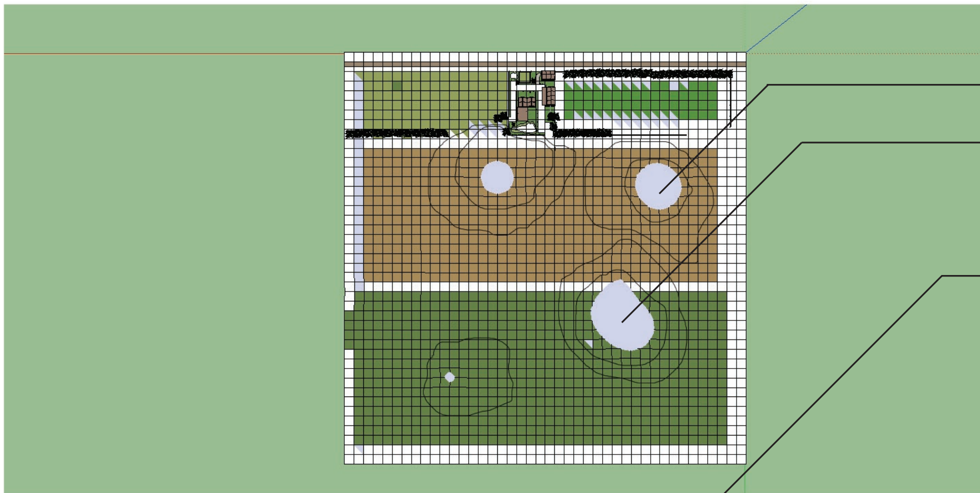
As a result we see a system that can barley sustain one land use at a time much less two, and rather than satisfy a specific system efficiently these pothole regions founder somewhere in the middle. Now many of theses instance are not designated wetlands, but reoccurring lowland areas that are based on soils, topography, and high water tables. Unfortunately because these potholes are not protected by federal law they are susceptible to the interest of the private land owner and are often disregarded. Many of these areas are subsequently drained creating a larger cumulative problem as multiple farmers contribute to excessive field run off. However the loop in protection creates a huge opening for these areas to be consolidated on site to better serve ecological sustainability, resource management, and improvement to the given areas crop productivity and stability. Also due to CRP, PLOT and EQIP management policy many of the lands under contract must be kept open to public land, pot hole consolidation on unregistered lowlands is keep in the private sector.

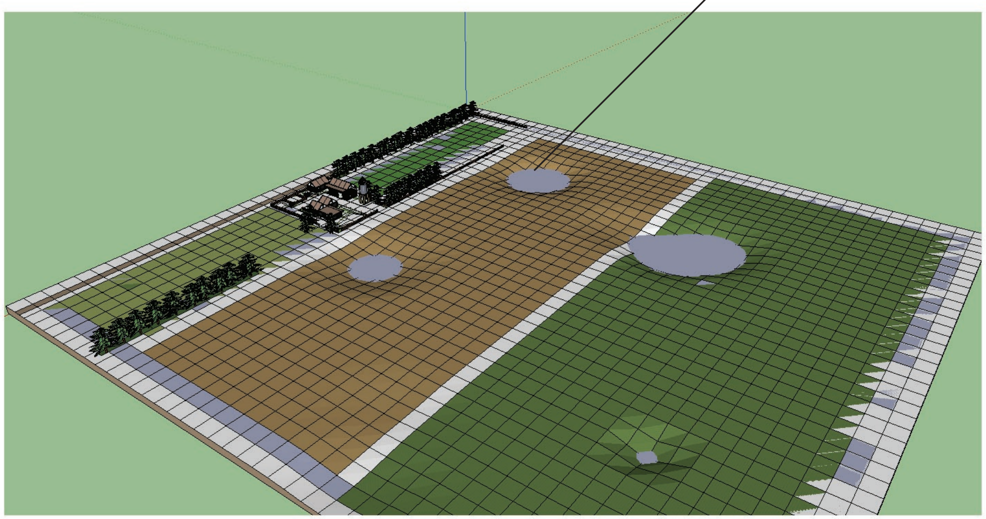
The following outlines practices and techniques used to foster ecological resilience while still improving crop production on private land.

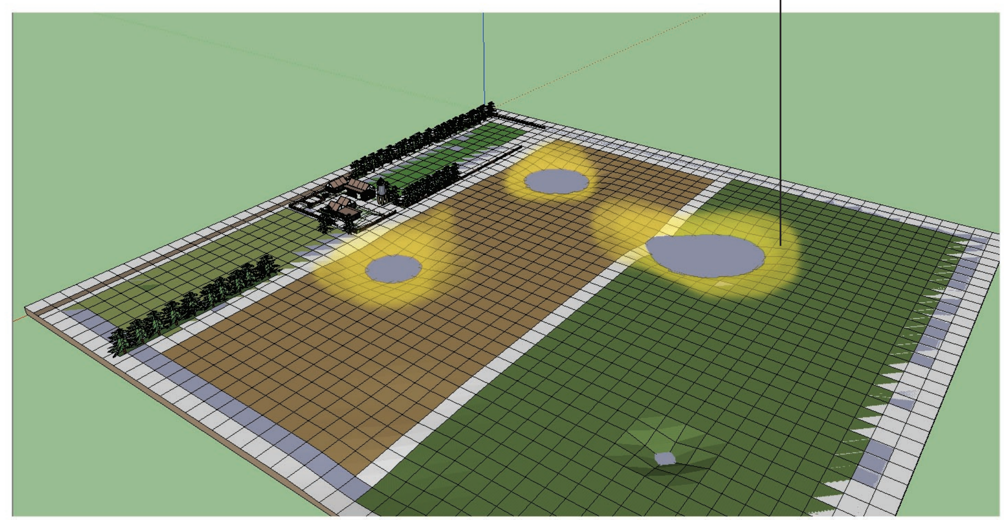
Area of most mutually beneficial productivity between crops and habitat lies in a balance between the water dispersion of a small pond and its internal depth and slope . Areas with low depth and slope lead to over dispersal of water resulting in a damaged crop zones without fulfilling any ecosystem service. While an over sized depth and slope does improve cropable land around the once degraded area, if the pond is to steep it provides no room for transitional change in the landscape and ecosystem, meaning less resilience to disturbances and an easier chance for the systems to founder and fail again.



Degraded Conditions







Pothole Depressions

Cropable space becomes unavailable due to hydrological fluctuations.

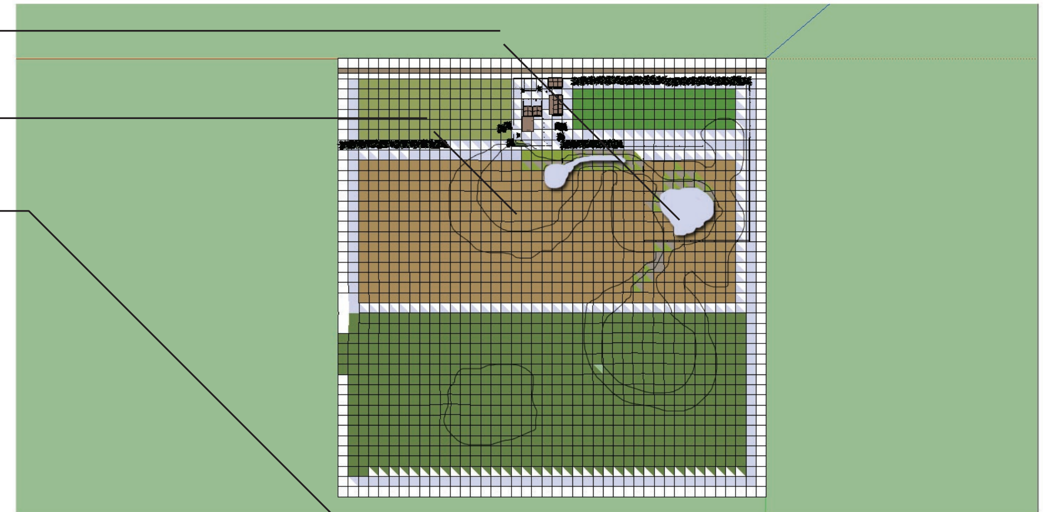
Water ponding cannot be used for ecological resiliency due to its occasional cropping and intense disturbance regime.

Soil and crop degradation extends beyond main detention area due to flat topography.

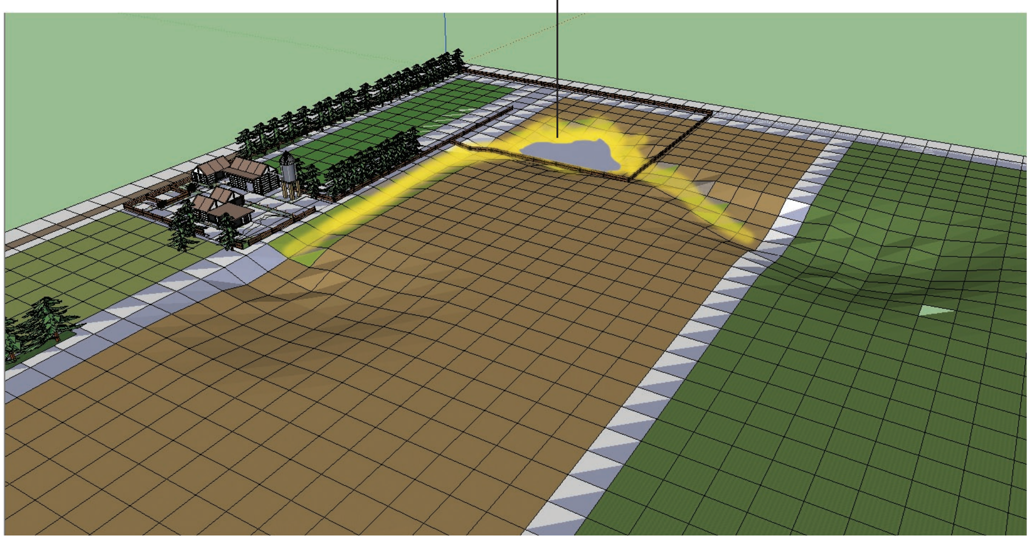
Consolidated lowland with more retention

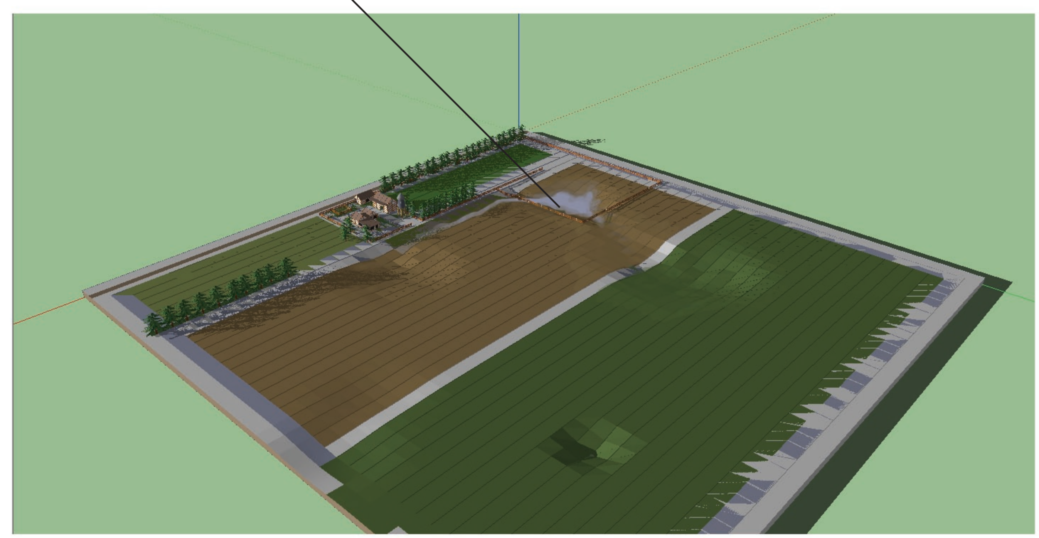
Available crop space in now stable growing conditions

Creates greater resilience due to preeminence in its given landscape and fostering of biodiversity.

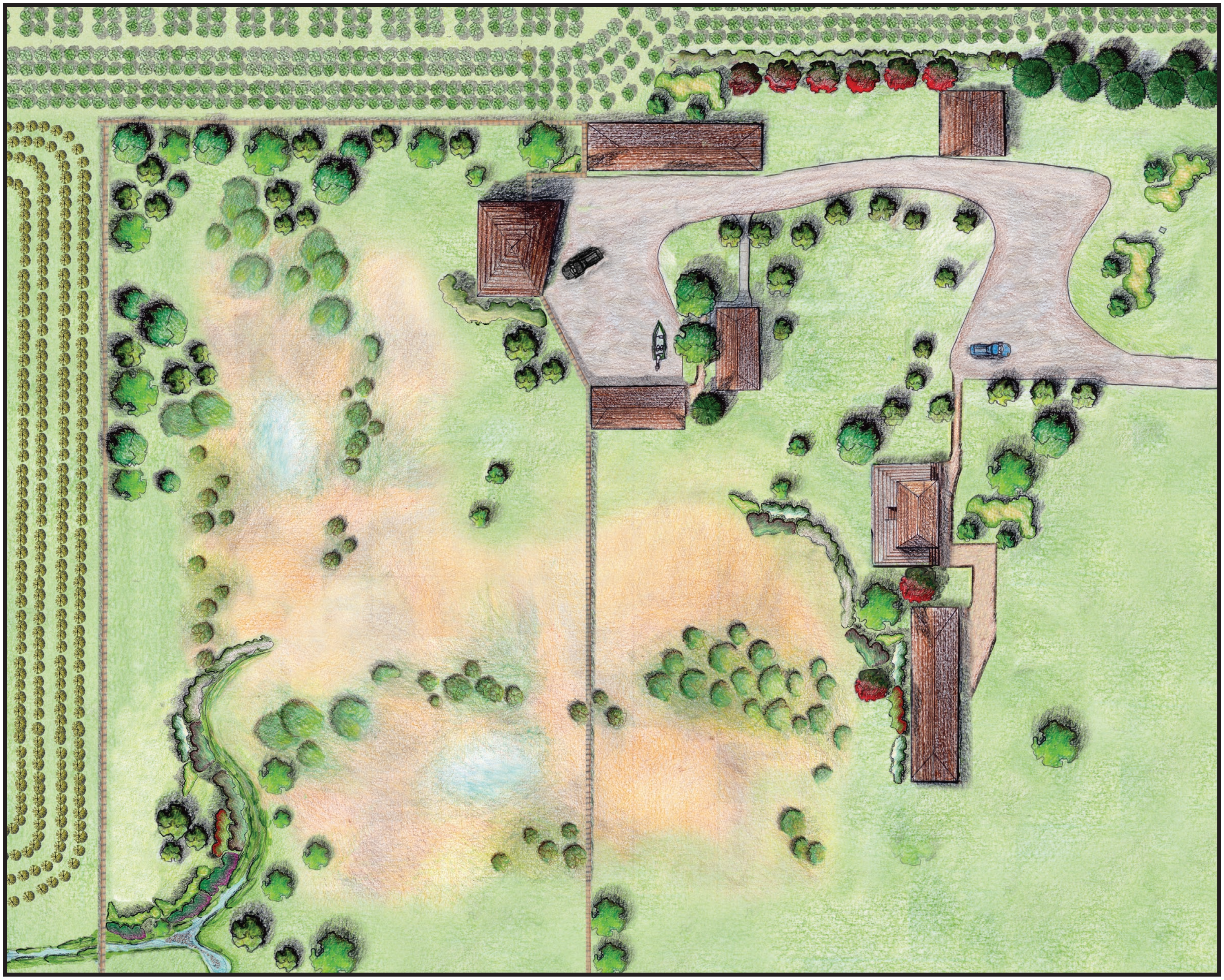


Deeper depressions allow for more retention and less overland flooding as well as continuing a water supply for life, habitat and runoff filtration





EXEMPLARY FARMSTEAD



Consolidated Wetland

Grazing allowed within wetland

Field drainage through Vegetative Swale

Windbreak / shelterbelt

Native Vegetation Planting

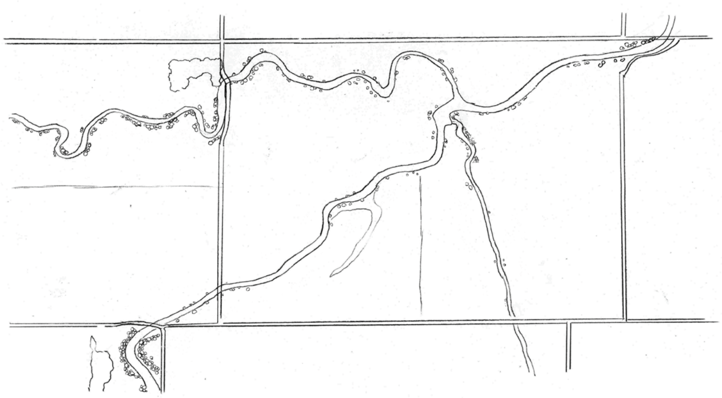
Riparian Boundary restoration

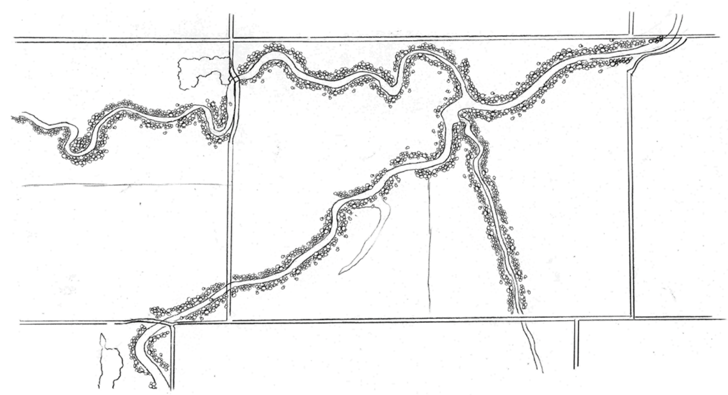
Erosion Control / habitat Corridors / Reduce stream fluctuations

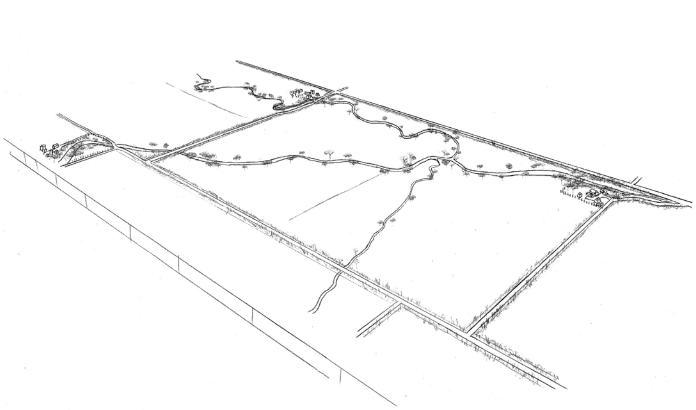
"The riparian corridor encompasses the stream channel and that portion of the terrestrial landscape from the high water mark toward the uplands where vegetation may be influenced by elevated water tables, or flooding, or by the ability of soils to hold water." (USFWS)

Riparian corridors include stream banks and associated areas adjacent to a flowing waterway. When vegetated, riparian areas function as stream buffer zones. There are many benefits of stream bank setbacks, including the protection from erosion. In addition, vegetative setbacks filter water pollutants (toxic chemicals, nutrients, and sediment) from runoff entering streams. They also function to prevent stream warming, and provide food, cover, and habitat structure for wildlife. The linear corridors provided by stream bank setbacks enhance wildlife movement and migration for sensitive species.

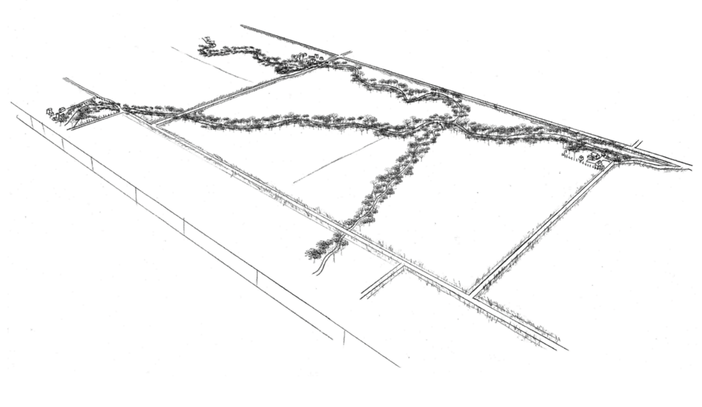
This common instance is located on a first order stream in a sub-watershed dominated by farming and ranching land uses. There are no dams or diversions up stream of the project site. The landowner cultivates a field devoted to small grain production within 50 ft of the stream. Pre-emergent herbicides are applied and the field is fertilized annually. Insecticides are also applied if needed. A segment of the proposed buffer is grazed and cattle access the river to drink. Surface erosion and bank sloughing occur in several cattle access locations. Invasive exotic plant species have established themselves in patches of varying sizes across the project site. The landowner's primary objective for the riparian buffer is to improve the quality of water leaving the property and entering the stream. However, the landowner also wants to improve habitat quality within the buffer for a diversity of riparian obligate and dependent species.







Degraded Conditions



Resilient Conditions

Flood Damage Reduction

Riparian buffers may reduce damages from flooding by:

—Storing water in soil, floodplains, and wetland
—Reducing peak flows of certain events
—Protecting stream banks from erosion
—Slowing flows in headwater streams

Water Quality

Mitigating plant flora have effects on water run-off quality:

-- Filters sediment from runoff
--Transforms and sequesters nutrients
- -Shades the river, moderating water temperatures
-- Provides opportunities for storm water treatment

Wildlife Habitat and Biodiversity

Essential to Aquatic system functions Essential functions

-- Used for nesting and feeding by variety of species .
-- Significant corridor for travel and migration by mammals and birds
—Riparian zone contributes 70--90% of food and energy to headwater streams.
—Large woody debris is important habitat for fish and aquatic insects.

** Table of Riparian Buffer effectiveness at removing Nitrate by vegetative cover

Vegetative Cover Type	Flow Path	Buffer Width	N form	Mean Influent (pmm)	Mean Effluent (pmm)	Effectiveness(%)	Major Soil type(s)
grass	surface	4.6	total N	–	–	-15	sandy loam
grass	surface	9.2		–	–	35	
grass	surface	7.5	total N	68	44	35	silty clay loam
grass	surface	15		68	33	51	
grass	surface	4.6	nitrate	1.86	2.37	-27	silt loam
grass	surface	9.1		1.86	2.13	-15	
grass	surface	4.6	nitrate	–	–	27	silt loam
grass	surface	9.1		–	–	57	
grass	surface	91	total N	21.6	13.3	38	–
grass	surface	27	nitrate	0.37	0.34	8	–
grass	surface	26	NH_3	3.61	3.05	16	very fine sandy loam
grass	surface	26	TKN	48.9	11.76	76	very fine sandy loam
grass	subsurface	25	nitrate	15.5	6.2	60	coarse sand
grass	subsurface	70	nitrate	1.55	0.32	80	fine sandy loam/silt loam
grass	subsurface	39	nitrate	16.5	3	82	silty clay loam
grass	subsurface	25	nitrate	12.15	1.92	84	peat/sand
grass	subsurface	16	nitrate	2.8	0.3	89	stony clay loam
grass	subsurface	10	nitrate	7	0.3	96	entisols/histosols
grass	subsurface	100	nitrate	375	<5	98	–
grass	subsurface	10	nitrate	7.54	0.05	99	silt loam
grass	subsurface	30	nitrate	44.7	0.45	99	sand/loamy sand
grass	subsurface	50	nitrate	6.6	0.02	100	fine sandy loam
grassforest	surface	7.5	total N	68	49	28	silty clay loam
grassforest	surface	15	total N	68	40	41	
grassforest	subsurface	6	nitrate	6.17	0.56	91	loam/sandy loam
grassforest	subsurface	70	nitrate	11.98	1.09	91	loamy sand
grassforest	subsurface	66	nitrate	5.8	0.17	97	gravel
grassforest	subsurface	33	nitrate	5.7	0.11	98	sandy loam/loamy sand
forest	subsurface	16	nitrate	6.6	0.3	95	stony clay loam
forest	subsurface	15	nitrate	–	–	96	–
forest	subsurface	165	nitrate	30.8	1	97	peat/sand
forest	subsurface	50	nitrate	6.26	0.15	98	peat/sand
forest	subsurface	220	nitrate	10.8	0.22	98	peat/loamy sand
forest	subsurface	50	nitrate	7.45	0.1	99	loamy sand
forest	subsurface	10	nitrate	13	0.1	99	silt loam
forest	subsurface	100	nitrate	5.6	0.02	100	sandy clay/coarse sand
forest	subsurface	30	nitrate	1.32	nd	100	silt clay
forest	subsurface	100	nitrate	12	nd	100	silt/plant debris/sand
forestwetland	surface	–	nitrate	0.34	0.07	81	sand
forestwetland	subsurface	31	nitrate	62.7	25.9	59	sand
forestwetland	subsurface	38	nitrate	30.6	6.7	78	sandy loam
forestwetland	subsurface	14.6	nitrate	–	–	84	sandy mixed mesic
forestwetland	subsurface	5.8	nitrate	–	–	87	sandy mixed mesic
forestwetland	subsurface	5.8	nitrate	–	–	90	sandy mixed mesic
forestwetland	subsurface	6.6	nitrate	–	–	97	loamy mixed mesic
forestwetland	subsurface	30	nitrate	1.06	nd	100	clay loam
wetland	surface	20	nitrate	57	50	12	peat/sand
wetland	surface	20		57	15	74	
wetland	subsurface	5	nitrate	6.56	1.55	76	stony silt loam
wetland	subsurface	5		3	1.44	52	
wetland	subsurface	1	nitrate	1	–	96	clay loam/clay
wetland	subsurface	200	nitrate	10.5	0.5	95	silt/sand/gravel
wetland	subsurface	40	nitrate	77.48	0.31	100	fine to coarse sand

Riparian (Forest) Buffer CP22

Purpose – To remove pollutants, create shade, and provide detritus.

Eligibility – Eligible cropland or marginal pasture land adjacent to permanent and seasonal streams and water bodies.

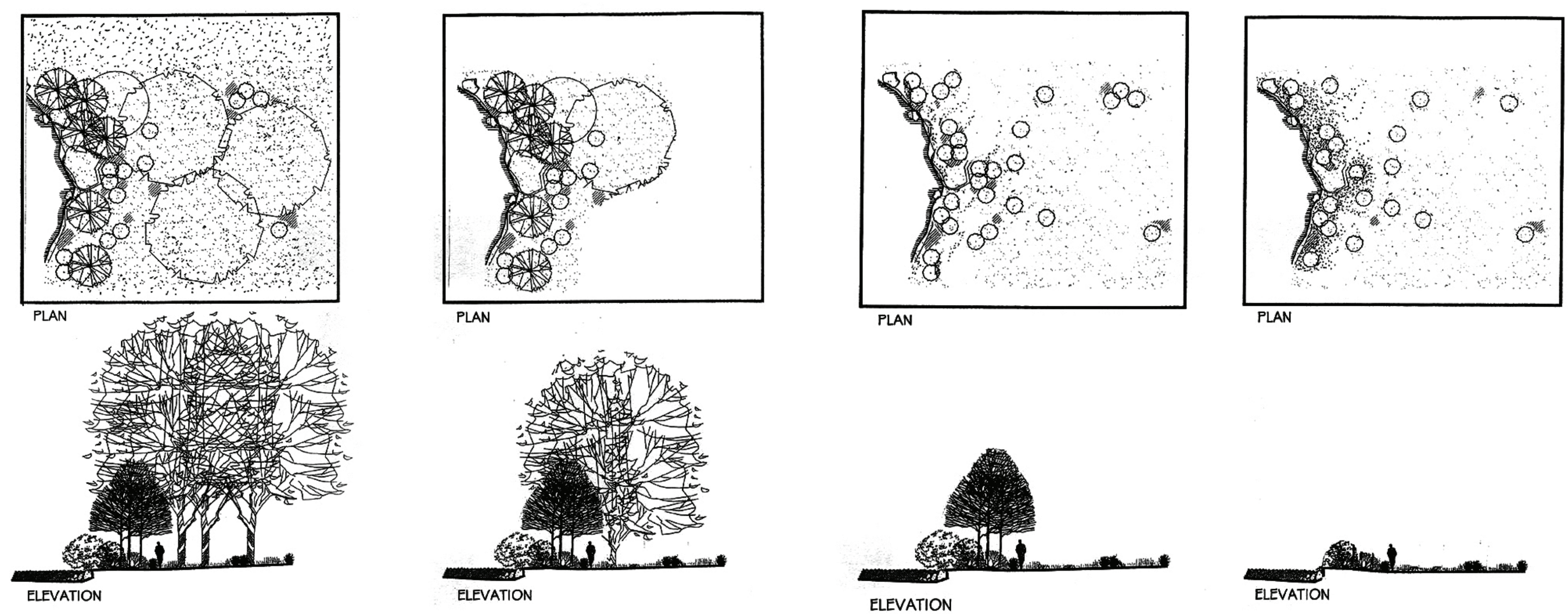
Size – Any length with an average width between 35 and 180 feet. It is recommended up to 20’ of grass (filter strip) be established up gradient from the trees and shrubs.

Maintenance – Control weeds as needed. Replant trees and shrubs if survival and volunteers plants together do not meet minimum stocking rates

Placement – Immediately adjacent to eligible water bodies. Contract may include a small part of noncropland acres to properly position the riparian forest buffer.

Sample economics of a 180’ wide riparian buffer along 2,000’ of perennial stream (8.26 acres)

- Costs including site preparation, planting, and first year weed control = $7,142.01*
- Reimbursement and incentives = $7,253.81
- 15 year rent payments = $5,203.80

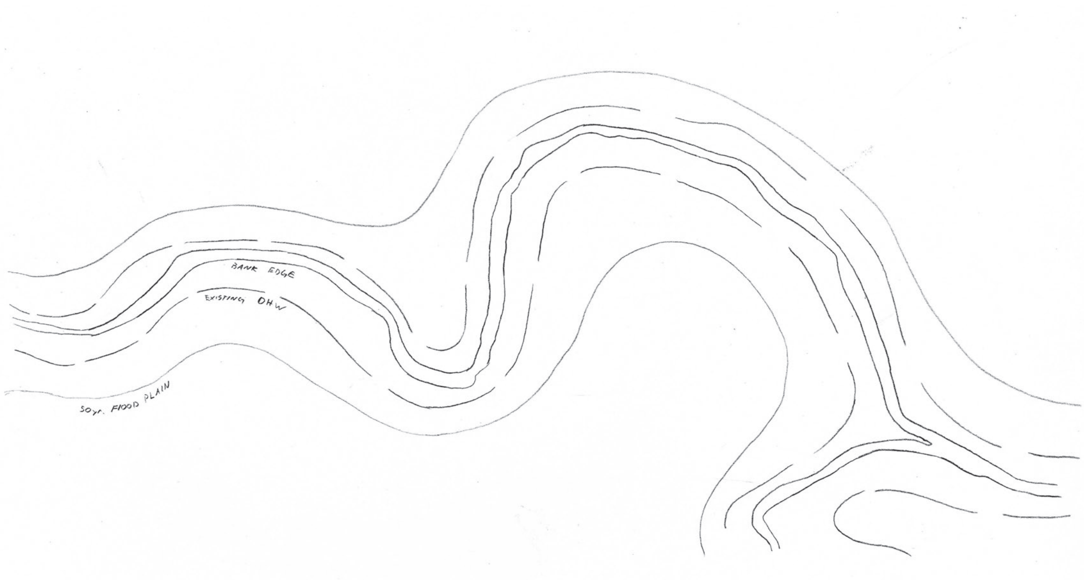


Basic steps to ecological Riparian design

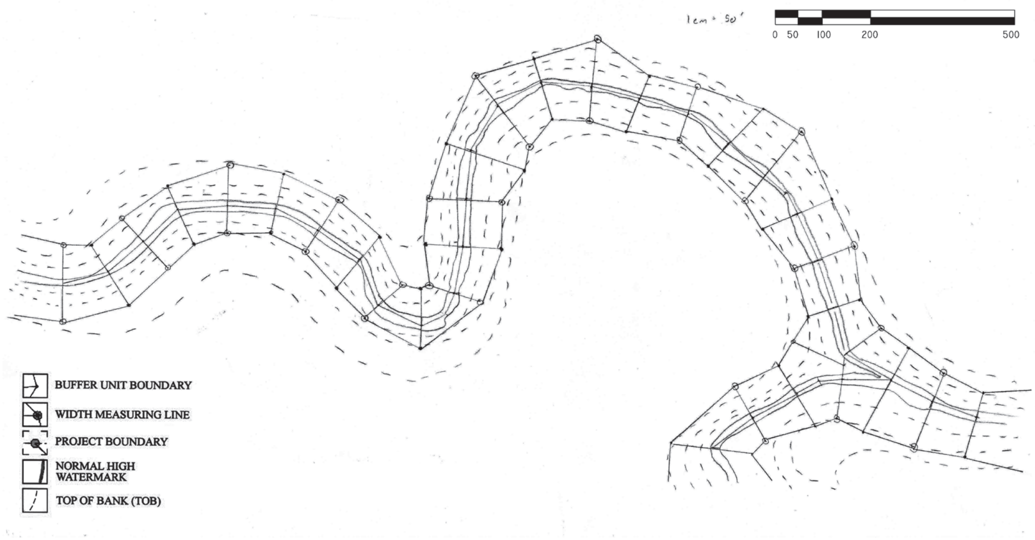
This riparian study is specific to the wild rice watershed and highlights the sequential preparation of maps used to illustrate buffer width recommendations that respond to various site attributes. Subsequent map are based on dimensions obtained from buffer width keys and matrices for water quality and wildlife habitat.

- Use the optimum water quality buffer configuration as the base map for wildlife habitat planning.
- Use the same baseline and discrete buffer units used for water quality buffer planning to prepare the wildlife habitat plan.
- Delineate the riparian/wetland and upland plant communities in each buffer unit on the base map.
- Determine the level of landowner willingness/ability to participate in a wildlife conservation project.
- Rate habitat suitability for target specie(s) by comparing existing riparian/wetland and/or upland plant community functional condition with habitat parameters for the target species.

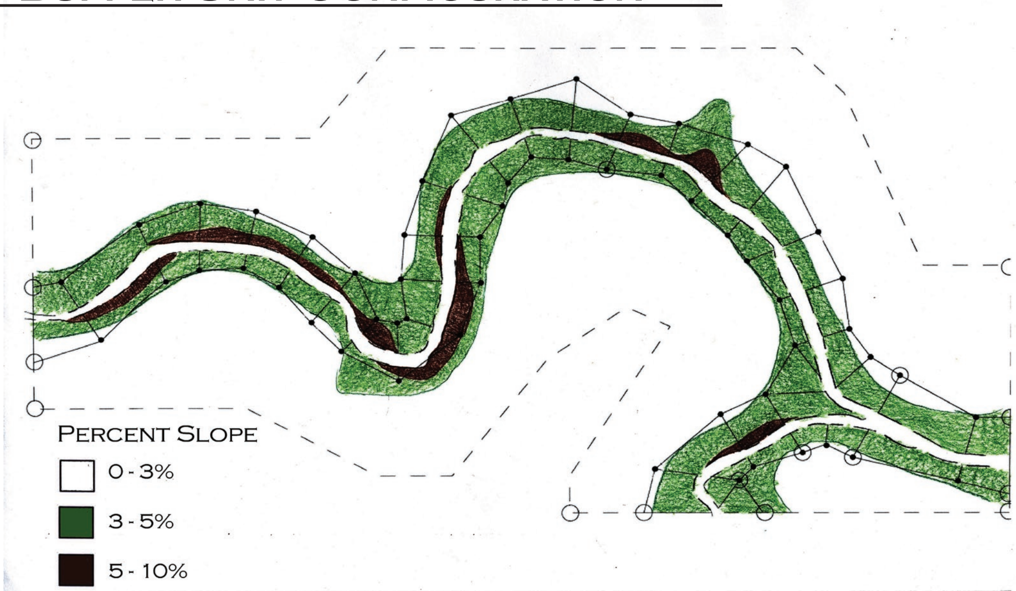
Existing conditions



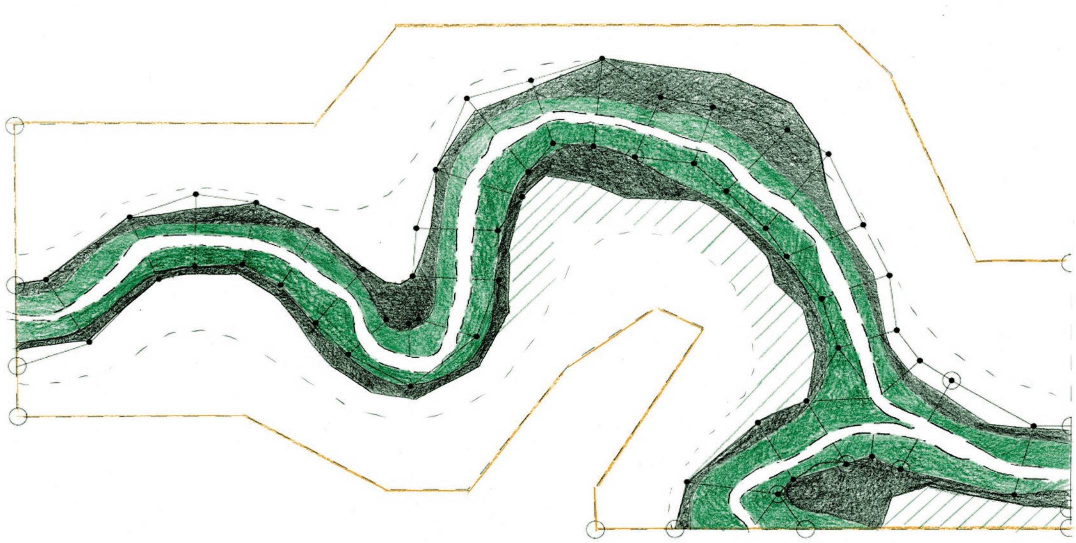
High water levels



Buffer Unit Configuration



Slope Plan



LAND USE AND MANAGMENT ZONES LEGEND:

ZONE 1

Zone 1 is a no-disturbance or no-harvest zone, exceptions include restoration, habitat enhancement and weed control

ZONE 2

Zone 2 is an area within which low impact land uses are permitted as well as the exceptions noted for Zone 1

ZONE 3

Zone 3 is the landscape on the landward edge of Zone 2, typically a working or urbanized landscape; best managment practices are recommended.

R REMNANT AREAS

For practical reasons (equipment operations or fencing) the landowner may consider incorporating these remnants into Zone 2

Land Use Management Zones

Index

Abbreviations Used in the Report

AF - Acre Feet

ASAP - Available Storage Acreage Program

BWSR - Board of Water and Soil Resources

CACFDAS - Computerized Agricultural Crop Flood Damage Assessment System

CCJWRD - Cass County Joint Water Resources District

DEIS - Draft Environmental Impact Statement

DNR - Department of Natural Resources

EBI - Environmental Benefits Index

FEMA - Federal Emergency Management Agency

GIS - Geographical Information Systems

NDSWC - North Dakota State Water Commission

NWI - National Wetlands Inventory

RIM - Reinvest In Minnesota

RRV - Red River Valley

USFWS - United States Fish and Wildlife Service

USGS - United States Geological Society

WRW - Wild Rice Watershed

WRWMB - Wild Rice Watershed Management Board

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Studio Experience

LA 271: Fall Semester 2007
Landscape Architecture I: Residential Design
Instructor: Kathleen Pepple
- Kennedy Court Vacant Lot – Fargo, ND
- Klai Hall Landscape- Fargo, ND

LA 272: Spring Semester 2008
Landscape Architecture II: Regional Park Design
Instructor: Mark Lindquist
- Pioneer Park – Valley City, ND
- Point Douglas Neighborhood- Winnipeg, Manitoba
- Ready-Mix Conrete Design Competition

LA 371: Fall Semester 2008
Landscape Architecture III: Site Topography
Instructor: Stevie Famulari
- Fargo Dike & Island Park – Fargo, ND
- Symphonic Alley- Fargo, ND

LA 372: Spring Semester 2009
Landscape Architecture IV: Community Design
Instructor: Kathleen Pepple
- Greenway neighborhood – Fargo, ND
- Lion's Club Park- Battle Lake, MN

LA 471: Fall Semester 2009
Advanced Landscape Architecture I: Urban Design
Instructor: Mark Lindquist
-Springwater Plaza – Portland, OR
- Central Lightrial Station - Portland, OR

LA 472: Spring Semester 2010
Advanced Landscape Architecture II: Phytoremediation
Instructor: Stevie Famulari
- Acid Canyon- Los Alamos, NM
- Hesco Basket Flood Mitigation Design Competition- Fargo, ND

LA 571: Fall Semester 2010
Advanced Landscape Architecture III: Environmental Planning
Instructor: Catherine Wiley
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